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Ministry of Science and Higher Education - Ethiopia

PHYSICAL FITNESS MODULE

(SpSc 1011)

Prepared By: Zerihun Birhanu (PhD)

(Bahir Dar University)

Haileyesus Gedefaw (PhD)

(Dilla University)

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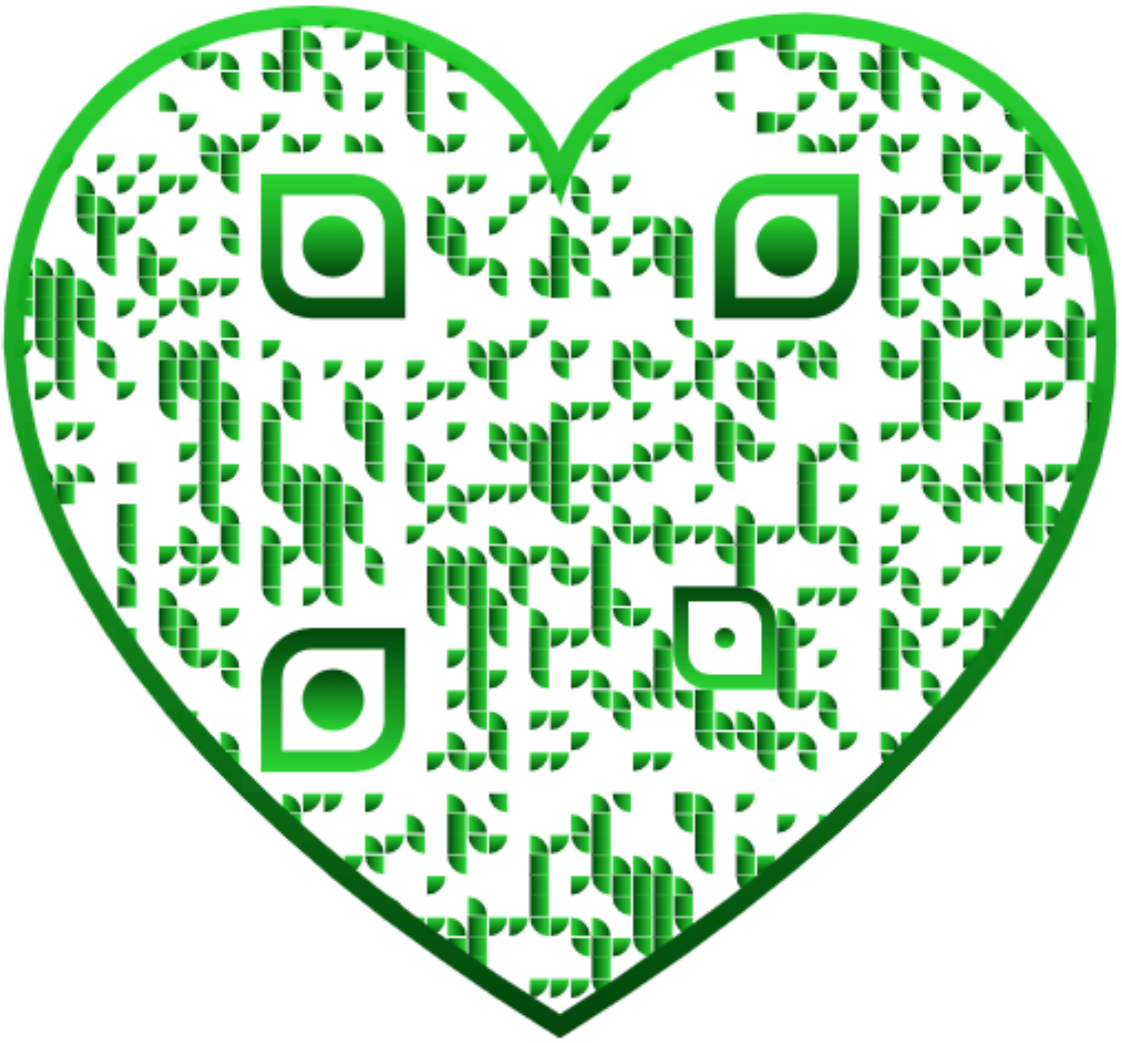

Preface

Since the beginning of time, survival has been a daily struggle. Simply staying alive was physically demanding. Yet, humans in industrialized societies over the last 150 years have come spoiled. We live in our minds so much of the time that we have almost forgotten that we have a body many people work in offices who make their living by reading, writing, speaking, and thinking, but seldom by physical labor. Regular physical exercise does the body good. Physical exercise empowers natural health advocates to take active measures to combat disuse atrophy. Physical fitness has a vital role in the life of men from time immemorial. The progress of the nation lies in the hands of people, who are healthy and physically fit. Every individual should develop physical fitness for a happy and effective living. Physical fitness is the ability to live a full and balanced life. The totally fit person has a healthy and happy outlook towards life. Fitness is the young man's absolute necessity. It breads breeds self-reliance and keeps man mentally alert. Physical fitness is essential for human beings to adjust well with his environment as his mind and body are in complete harmony. In order to get physical fitness one has to involve in a regular physical exercise program. Our bodies demand to be used. Failure to use them results in your muscles deteriorating, at a steady and progressive rate. Thus, everyone should develop sensible habits of exercise that they can stick to for the rest of their lives.

To help you understand about physical fitness and related issues, this module provides you all the necessary information regarding what physical fitness is, the various components of physical fitness, means by which physical fitness is developed, methods of assessing physical fitness and the health benefits of physical exercise.

Table of Contents

Unit 1: Concepts of physical fitness....1
1.1. Meanings and definitions of terms....2
1.1.1. Physical fitness....2
1.1.2. Physical Activity....3
1.1.3.Physical exercise....4
1.1.4. Sport....5
1.2. General principles of fitness training....6
1.2.1 Principle of Overload....6
1.2.2 FIIT Principle....7
1.2.3 Principle of Rest, Recovery and Periodization....10
1.2.4 Principle of Reversibility....12
1.2.5 Principle of Individual Deference....13

Unit 2: The Health Benefits of Physical Activity....16
2.1. Physical Activity and Hypokinetic Diseases/Conditions....17
2.2. Physical Activity and Cardiovascular Diseases....22
2.2.1 Coronary Heart Disease....22
2.2.2 Hypertension....23
2.2.3 Hyper-cholesterolemia and Dyslipidemia....25
2.2.4 Diabetes Mellitus....26
2.2.5 Obesity and Overweight....27
2.2.6 Metabolic Syndrome....28
2.2.7 Aging....29
2.3. Physical activity and postural deformity....30
2.3.1 Musculoskeletal disease and disorders....31

Unit 3: Making Well-Informed Food Choices....34
3.1. Sound Eating Practices....34
3.1.1 Macronutrients....35
3.1.2 Micronutrient....35
3.1.3 Calories (Food Energy)....35

3.2. Nutrition and Physical Performance 43
3.2.1 Nutrition Before Exercise 44
3.2.2 Nutrition During Exercise 47
3.2.3 Nutrition After Exercise 50
3.2.4 How to Plan Your Training Diet 52

Unit 4: Health related components of fitness and principles of exercise prescription 54
4.1. Health Related Components of Fitness 54
4.1.1 Cardio respiratory Fitness 55
4.1.2 Muscle Fitness 55
4.1.3 Flexibility 59
4.1.4 Body Composition 61
4.2. Principles of exercise prescription for health and fitness 66
4.2.1 Fitness Goals 67
4.2.2 Mode of Exercise 69
4.2.3 Warm Up 69
4.2.4 Primary Conditioning Period: The Workout Plan 70
4.2.5 Cool – Down 71
4.3. Individualizing workout 71
4.4. Means and methods of developing cardiorespiratory fitness 72
4.4.1 Exercise prescription for Cardiorespiratory Fitness 72
4.4.2 Starting and Maintaining a Cardiorespiratory Fitness Program 77
4.4.3 Training Techniques 79
4.5. Means and methods of developing muscle fitness 82
4.5.1 Guiding Principles for Designing a Strength and Endurance Program 82
4.5.2 Types of Weight Training Programs 84
4.5.3 Exercise Prescription for Weight Training: an overview 85
4.5.4 Developing an Individualized Exercise Prescription 87
4.6. Means and methods of developing flexibility 88
4.6.1 Exercise Prescription for Improving Flexibility 88

4.6.2 How to Avoid Hazardous Exercise....89

Unit 5: Assessment of fitness components....91
5.1.....Evaluating Health Status....91
5.2.....Assessment of cardiorespiratory fitness....92
5.2.1 .....The 1.5 Mile Run Test....92
5.2.2 .....The 1 Mile Walk Test....94
5.2.3 .....The Cycle Ergometer Fitness Test....95
5.2.4 .....The Step Test....95
5.3.....Assessment of Muscle Fitness....96
5.3.1. .....Assessing muscular strength....96
5.3.2. .....Assessing muscular endurance....98
5.4.....Assessment of flexibility....101
5.4.1 .....Trunk Flexibility....102
5.4.2 .....Shoulder Flexibility....102
5.5.....Assessment of body composition....103
5.5.1 .....The Skin Fold Test....104
5.5.2 .....Estimation of Body Composition: Other Field Techniques....107

Reference....109

UNIT ONE

CONCEPTS OF PHYSICAL FITNESS

UNIT OBJECTIVES

By the end of this unit you should be able to:

- Define physical fitness, physical activity, physical exercise and sport
- Understand the benefits of physical fitness
- Realize general principles of fitness training
- Make behaviour modification to stay fit

INTRODUCTION

As most college students do, you have probably set goals. Obviously, your individual goals differ from those of your fellow classmates, but everyone's goals share one common attribute: their intention to improve individual wellbeing. However, there are as many ideas about how to do that as there are individuals. Do your goals involve making more money, achieving better health, improving your relationships? Holistic wellness involves all those aspects of life and more. Maintaining physical fitness and ever stayed conditioned has a lion share for wellness though.

This unit explains the concepts of physical fitness which might assist you to stay fit to exude confidence, optimism, and self-efficacy; they have the energy reserves to do what needs to be done today and to plan for a better tomorrow. The most effective and transformative goals are those designed to achieve the highest level of personal wellness.

1.1. Meanings and Definitions of Terms

1.1.1 Physical fitness

It is an ability to meet the ordinary, as well as unusual demands of daily life *safely* and *effectively* without being overly fatigued. Simply it is the body's ability to function effectively and efficiently, and contributes the total quality of life.

The totally fit person has a healthy and happy outlook towards life. Fitness is the young man's absolute necessity. It breeds self- reliance and keeps man mentally alert. Physical fitness is essential for human beings to adjust well with his environment as his mind and body are in complete harmony.

It is generally agreed that physical fitness is an important part of the normal growth and development of a child, a generic definition regarding the precise nature of physical fitness has not been universally accepted. Through research and scholarly inquiry, it is clear that the multi-dimensional characteristics of physical fitness can be divided into two areas: health related physical fitness and skill related physical fitness (see Unit Four).

Clarke and Clarke (1989) found that physical fitness is not a static factor and it varies from individual to individual and in the same person from time to time depending on factors. Physical fitness is probably the most popular and frequently used term in physical education. The most important objective of physical educators is to develop physical fitness. According to Nixon and cozens (1964), it was the desire to establish a scientific approach to the development of physical fitness which formed the basis of the first meeting of physical educators in 1885 when the profession of physical education originated.

The United States president's Council on physical fitness and sports defined the terms "physical fitness as the ability to carry out daily task with vigor and alertness, without undue fatigue, with ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies" (Clarke, 1971).

General fitness implies the ability of a person to live most effectively with his and her potentials, which depend upon the physical, mental, emotional, social and spiritual components of fitness which are highly interrelated.

Activity 1.1

Dear Student, discuss on the following questions with your partners.

1. *Would you try to provide a very simple working definition for the term physical fitness?*
2. *How do you further classify physical fitness?*
3. *Tell the conceptual dimensions of fitness in general.*

1.1.2 Physical Activity

It is bodily movement produced by skeletal muscles that results in energy expenditure. The term, physical activity, does not require or imply any specific aspect or quality of movement. The term encompasses all types, intensities, and domains. Although the term "physical activity" has been used often as a short-hand description for moderate-to-vigorous-intensity forms of physical activity, given current interest and discussions about physical activity of intensities less than moderate-intensity, the term "physical activity" should be used when discussing the full range of intensities. More specific descriptors such as sedentary behavior, light, moderate, vigorous, or moderate-to-vigorous should be used when talking about a specific range of intensities. Based on predominant physiologic effect, physical activity can be categorized in to aerobic physical activity and anaerobic physical activity.

Aerobic physical activity includes forms of activity that are intense enough and performed long enough to maintain or improve an individual's cardiorespiratory fitness. Aerobic activities such as walking, basketball, soccer, or dancing, commonly require the use of large muscle groups. The connection between aerobic activities such as these and cardiorespiratory fitness is sufficiently close that the term "aerobic capacity" is considered equivalent to cardiorespiratory fitness. Technically, aerobic physical activity includes any activity that could be maintained using only oxygen-supported metabolic energy pathways and could be continued for more than a few minutes. However, in both common and scientific usage, "aerobic" activity has come to mean physical activity that would be expected to maintain or improve cardiorespiratory fitness or

aerobic capacity. Whereas, anaerobic physical activity refers to high-intensity activity that exceeds the capacity of the cardiovascular system to provide oxygen to muscle cells for the usual oxygen consuming metabolic pathways.

Anaerobic activity can be maintained for only about 2 to 3 minutes. Sprinting and power lifting are examples of anaerobic physical activity.

1.1.3 Physical Exercise

The term "exercise" has been used interchangeably with "physical activity", and, in fact, both have a number of common elements. For example, both physical activity and exercise involve any bodily movement produced by skeletal muscles that expends energy, are measured by kilocalories ranging continuously from low to high, and are positively correlated with physical fitness as the intensity, duration, and frequency of movements increase. Exercise, however, is not synonymous with physical activity: it is a subcategory of physical activity.

Exercise is physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective. The formula relating physical activity and exercise is:

$$\mathbf{kcal}_{\text{Exerclse}} + \mathbf{kcal}_{\text{Nonexercise}}` = \mathbf{kcal}_{\text{Total daily Physical activity}}$$

Physical activity is complex behavior, however, and may be meaningfully partitioned into other categories mutually exclusive of each other but not activity except sleep. However, it is more likely to be an important part of some categories of physical activity than of others. For example, virtually all conditioning and many sports activities are performed to improve or maintain components of physical fitness. In such instances they are planned, structured, and, more often than not, repetitive.

Activities such as occupational, household and many daily tasks are typically performed in the most efficient manner possible. These physical activities are done with little regard to physical fitness and are often structured with conservation of energy expenditure as a goal. However, a worker may plan and structure the performance of some work tasks in a less efficient manner to

develop muscular strength or to "burn up" calories. Similarly, a person may plan and structure the performance of household or other tasks in a labor producing rather than a labor-saving manner. Tasks regularly performed in this manner are considered exercise.

Generally, Exercise describes as planned structured and repetitive bodily movement done to improve or maintain one or more components of physical fitness and is subset of physical activity. Exercise is usually goal related and designed in the sense that the improvement or maintenance of one or more components of physical fitness (i.e., endurance, strength, flexibility etc…).

Activity 1.2

Dear Student, would you try to mention the elements of Physical Activity and Exercise in the box below?

Physical Activity	***Exercise***

1.1.4 Sport

It is an organized, competitive form of play. Some persons view sport simply as an organized form of play, which might put it closer to physical education as we have defined it. However, close consideration will show that sport has traditionally involved competitive activities.

When we refer to sport as “organized” competitive activity, we mean that the activity has been refined and formalized to some degree- that is, some definite form or process involved. Rules, whether they are written or not, are involved in this form of activity, and these rules or procedures can not be changed during the competition, though new ones may involve from one episode to the next. Sport is, above all, competitive activity. We cannot think of sport without thinking of competition, for without the competition, sport becomes simply play or recreation.

Play can at times be sport, but strictly speaking, sport is never simple play; the competitive aspect is essential to the nature of sport.

Activity 1.3

Dear Student, discuss on the following questions with your partners.

1. *One way of defining sport is as "organized" competitive activity, what do we mean by that?*
2. *And how do you differentiate sport from other forms of exercise and physical activity?*

1.2 General Principles of Fitness Training

The human body adapts well when exposed to stress. The term *stress*, within the context of exercise, is defined as an exertion above the normal, everyday functioning. The specific activities that result in stress vary for each individual and depend on a person's level of fitness. For example, a secretary who sits at a desk all day may push his/her cardiorespiratory system to its limits simply by walking up several flights of stairs. For an avid runner, resistance training may expose the runner's muscles to muscular contractions the athlete is not accustomed to feeling. Although stress is relative to each individual, there are guiding principles in exercise that can help individuals manage how much stress they experience to avoid injury and optimize their body's capacity to adapt. Knowing a little about these principles provides valuable insights needed for organizing an effective fitness plan.

1.2.1 Principle of Overload

Consider the old saying, "No pain, No gain." Does exercise really have to be painful, as this adage implies, to be beneficial? Absolutely not. If that were true, exercise would be a lot less enjoyable. Perhaps a better way to relay the same message would be to say that improvements are driven by stress. Physical stress, such as walking at a brisk pace or jogging, places increased stress on the regulatory systems that manage increased heart rate and blood pressure, increased energy production, increased breathing, and even increased sweating for temperature regulation. As these subsequent adaptations occur, the stress previously experienced during the same

activity, feels less stressful in future sessions. As a result of the adaptation, more stress must be applied to the system in order to stimulate improvements, a principle known as the overload principle.

For example, a beginning weightlifter performs squats with 10 repetitions at 150 pounds. After 2 weeks of lifting this weight, the lifter notices the 150 pounds feels easier during the lift and afterwards causes less fatigue. The lifter adds 20 pounds and continues with the newly established stress of 170 pounds. The lifter will continue to get stronger until his/her maximum capacity has been reached, or the stress stays the same, at which point the lifter's strength will simply plateau. This same principle can be applied, not only to gain muscular strength, but also to gain flexibility, muscular endurance, and cardiorespiratory endurance.

Activity 1.4

Dear Student, discuss on the following questions with your partners.

1. *Does the old saying, "No pain, No gain" satisfy the principle of overload?*
2. *If we don't respect the principle of overload during training what would be the ultimate consequence?*

1.2.2 FITT Principle

In exercise, the amount of stress placed on the body can be controlled by four variables: **F**requency, **I**ntensity, **T**ime (duration), and **T**ype, better known as FITT. The FITT principle, as outlined by the American College of Sports Medicine (ACSM) falls under the larger principle of overload.

A. Frequency and Time

Each variable can be used independently or in combination with other variables to impose new stress and stimulate adaptation. Such is the case for frequency and time.

Frequency relates to how often exercises are performed over a period of time. In most cases, the number of walking or jogging sessions would be determined over the course of a week. A

beginner may determine that 2–3 exercise sessions a week are sufficient enough to stimulate improvements. On the other hand, a seasoned veteran may find that 2–3 days is not enough to adequately stress the system. According to the overload principle, as fitness improves, so must the stress to ensure continued gains and to avoid plateauing.

The duration of exercise, or time, also contributes to the amount of stress experienced during a workout. Certainly, a 30-minute brisk walk is less stressful on the body than a 4-hour marathon.

Although independent of one another, frequency and time are often combined into the blanket term, volume. The idea is that volume more accurately reflects the amount of stress experienced. This can be connected to the progression principle. For example, when attempting to create a jogging plan, you may organize 2 weeks like this:

- Week 1: three days a week at 30 minutes per session
- Week 2: four days a week at 45 minutes per session

At first glance, this might appear to be a good progression of frequency and time. However, when calculated in terms of volume, the aggressive nature of the progression is revealed. In week 1, three days at 30 minutes per session equals 90 minutes of total exercise. In week two, this amount was doubled with four days at 45 minutes, equaling 180 minutes of total exercise. Doing too much, too soon, will almost certainly lead to burnout, severe fatigue, and injury. The progression principle relates to an optimal overload of the body by finding an amount that will drive adaptation without compromising safety.

B. Type of Exercise

Simply put, the type of exercise performed should reflect a person's goals. In cardiorespiratory fitness, the objective of the exercise is to stimulate the cardiorespiratory system. Other activities that accomplish the same objective include swimming, biking, dancing, cross country skiing, aerobic classes, and much more. As such, these activities can be used to build lung capacity and improve cellular and heart function.

However, the more specific the exercise, the better. While vigorous ballroom dancing will certainly help develop the cardiorespiratory system, it will unlikely improve a person's 10k time. To improve performance in a 10k, athletes spend the majority of their time training by running, as they will have to do in the actual 10k. Cyclists training for the Tour de France, spend up to six hours a day in the saddle, peddling feverishly. These athletes know the importance of training the way they want their body to adapt. This concept, called the principle of specificity, should be taken into consideration when creating a training plan.

In this discussion of type and the principle of specificity, a few additional items should be considered. Stress, as it relates to exercise, is very specific. There are multiple types of stress. The three main stressors are metabolic stress, force stress, and environmental stress. Keep in mind, the body will adapt based on the type of stress being placed on it.

Metabolic stress results from exercise sessions when the energy systems of the body are taxed. For example, sprinting short distances requires near maximum intensity and requires energy (ATP) to be produced primarily through anaerobic pathways, that is, pathways not requiring oxygen to produce ATP. Anaerobic energy production can only be supported for a very limited time (10 seconds to 2 minutes). However, distance running at steady paces requires aerobic energy production, which can last for hours. As a result, the training strategy for the distance runner must be different than the training plan of a sprinter, so the energy systems will adequately adapt.

Likewise, force stress accounts for the amount of force required during an activity. In weightlifting, significant force production is required to lift heavy loads. The type of muscles being developed, fast-twitch muscle fibers, must be recruited to support the activity. In walking and jogging, the forces being absorbed come from the body weight combined with forward momentum. Slow twitch fibers, which are unable to generate as much force as the fast twitch fibers, are the type of muscle fibers primarily recruited in this activity. Because the force requirements differ, the training strategies must also vary to develop the right kind of musculature.

Environmental stress, such as exercising in the heat, places a tremendous amount of stress on the thermoregulatory systems. As an adaptation to the heat, the amount of sweating increases as does plasma volume, making it much easier to keep the body at a normal temperature during exercise. The only way to adapt is through heat exposure, which can take days to weeks to properly adapt.

In summary, to improve performance, being specific in your training, or training the way you want to adapt, is paramount.

C. Intensity

Intensity, the degree of difficulty at which the exercise is carried out, is the most important variable of FITT. More than any of the other components, intensity drives adaptation. Because of its importance, it is imperative for those beginning a fitness program to quantify intensity, as opposed to estimating it as hard, easy, or somewhere in between. Not only will this numeric value provide a better understanding of the effort level during the exercise session, but it will also help in designing sessions that accommodate individual goals.

How then can intensity be measured? Heart rate is one of the best ways to measure a person's effort level for cardiorespiratory fitness. Using a percentage of maximum lifting capacity would be the measure used for resistance training.

Activity 1.5

Dear Student, recall the FITT principle and complete the exercise recommendation for an average adult.

Principle	***Training Recommendations***
Frequency	
Intensity	
Time	
Type	

1.2.3 Principle of Rest, Recovery, and Periodization

For hundreds of years, athletes have been challenged to balance their exercise efforts with performance improvements and adequate rest. The principle of rest and recovery (or principle of recuperation) suggests that rest and recovery from the stress of exercise must take place in proportionate amounts to avoid too much stress. One systematic approach to rest and recovery has led exercise scientists and athletes alike to divide the progressive fitness training phases into blocks, or periods. As a result, optimal rest and recovery can be achieved without overstressing the athlete. This training principle, called periodization, is especially important to serious athletes but can be applied to most exercise plans as well. The principle of periodization suggests that training plans incorporate phases of stress followed by phases of rest. Training phases can be organized on a daily, weekly, monthly, and even multi-annual cycles, called micro-, meso-, and macrocycles, respectively. An example of this might be:

Table 1.1:- Periodization Example

Week	Frequency	Intensity	Time	Type
1	3 days	40% HRR	25 min	Walk
2	4 days	40% HRR	30 min	Walk
3	4 days	50% HRR	35 min	Walk
4	2 days	30% HRR	30 min	Other

As table 1.1 shows, the volume and intensity changes from week 1 to week 3. But, in week 4, the volume and intensity drops significantly to accommodate a designated rest week. If the chart were continued, weeks 5-7 would be “stress” weeks and week 8 would be another rest week. This pattern could be followed for several months.

Without periodization, the stress from exercise would continue indefinitely eventually leading to fatigue, possible injury, and even a condition known as **overtraining syndrome**. Overtraining syndrome is not well understood. However, experts agree that a decline in performance resulting from psychological and physiological factors cannot be fixed by a few days’ rest. Instead, weeks, months, and sometimes even years are required to overcome the symptoms of overtraining syndrome. Symptoms include the following:

- weight loss

- loss of motivation
- inability to concentrate or focus
- feelings of depression
- lack of enjoyment in activities normally considered enjoyable
- sleep disturbances
- change in appetite

Activity 1.6

Dear Student, discuss on the following questions with your partners.

1. *What is the underlined principle of rest, recovery and periodization for better physical performance and health?*
2. *Define Microcycle, Mesocycle, and Macrocycle of Periodization.*
3. *How do you avoid overtraining?*

1.2.4 Principle of Reversibility

Chronic adaptations are not permanent. As the saying goes, “Use it or lose it.” The principle of reversibility suggests that activity must continue at the same level to keep the same level of adaptation. As activity declines, called detraining, adaptations will recede.

In cardiorespiratory endurance, key areas, such as VO2max, stroke volume, and cardiac output all declined with detraining while submaximal heat rate increased. In one study, trained subjects were given bed rest for 20 days. At the end of the bed rest phase, VO2max had fallen by 27% and stroke volume and cardiac output had fallen by 25%. The most well-trained subjects in the study had to train for nearly 40 days following bed rest to get back into pre-rest condition. In a study of collegiate swimmers, lactic acid in the blood after a 2-minute swim more than doubled after 4 weeks of detraining, showing the ability to buffer lactic acid was dramatically affected.

Not only is endurance training affected, but muscular strength, muscular endurance, and flexibility all show similar results after a period of detraining.

Activity 1.7

Dear Student, discuss on the following questions with your partners.

1. *What does "Use it or lose it" refers considering the principle of reversibility?*
2. *What are the detraining effects of exercise?*

1.2.5 Principle of Individual Differences

While the principles of adaptation to stress can be applied to everyone, not everyone responds to stress in the same way. In the HERITAGE Family study, families of 5 (father, mother, and 3 children) participated in a training program for 20 weeks. They exercised 3 times per week, at 75% of their VO2max, increasing their time to 50 minutes by the end of week 14. By the end of the study, a wide variation in responses to the same exercise regimen was seen by individuals and families. Those who saw the most improvements saw similar percentage improvements across the family and vice versa. Along with other studies, this has led researchers to believe individual differences in exercise response are genetic. Some experts estimate genes to contribute as much as 47% to the outcome of training.

In addition to genes, other factors can affect the degree of adaptation, such as a person's age, gender, and training status at the start of a program. As one might expect, rapid improvement is experienced by those with a background that includes less training, whereas those who are well trained improve at a slower rate.

Activity 1.8

Dear Student, discuss on the following questions with your partners.

1. *What does the principle of individual difference states?*
2. *What factors can affect the degree of adaptation to exercise stress?*

UNIT SUMMARY

- **Physical activity:** any activity that requires skeletal muscle and requires energy aimed at improving health.
- **Exercise:** a subset of physical activity that is planned and structured aimed at improving fitness.
- **Health related components of fitness:** types of activities dedicated to improving physical fitness categorized as cardiorespiratory endurance, muscular strength and endurance, flexibility, and body composition.
- **Skills related components of fitness:** types of activities dedicated to improving physical skills categorized as speed, agility, coordination, balance, power, and reaction time.
- **Principles of adaptations to stress:** guidelines related to managing the application of stress during physical activity/exercise.
- **Overload Principle:** a principle of adaptation to stress suggesting the amount of stress applied during exercise must exceed a threshold level to stimulate adaptation.
- **Volume:** the term used to describe "how much" stress is being applied by combining the duration and frequency of exercise.
- **Progression principle:** a principle relating to how much additional stress that can safely be introduced to gradually improve fitness without risking injury or overuse.
- **Specificity:** the principle of stress suggesting activities should be closely centered around the primary outcome goal, i.e. train the way you want to adapt.

- **Reversibility:** the principle that adaptations to stress can be lost over time if training is modified or stopped.
- **Principle of rest and recovery:** the concept that adaptation not only requires overload but also requires rest to avoid overstressing the body.
- **Periodization:** a method of organizing workouts into blocks or periods. These cycles consist of work/stress periods and rest periods.
- **Overtraining syndrome:** a condition of chronic stress from physical activity affecting the physical and psychological states of an individual or athlete.
- **Detraining:** the act of no longer training at all or decreasing the amount of training.

SELF-TEST EXERCISE

1. The term exercise refers to physical activity that is:
   a. Discontinuous and unplanned but designed to improve fitness
   b. Planned, structured, and repetitive designed to improve fitness
   c. Not a contributor to physical fitness
   d. Random and unstructured
2. Which of the following is NOT considered a skill-related fitness component?
   a. Coordination
   b. Flexibility
   c. Balance
   d. Agility
3. During the initial phase of an exercise program, a beginner should:
   a. Begin slowly, exercising at a low intensity and gradually increasing volume
   b. Keep intensity high, exercise at the high end of the target heart rate range
   c. Perform short but intense bouts of activity
   d. Exercise 5-7 days per week
4. The body's ability to adapt to gradual increases in the amount of exercise is the principle of:
   a. Overload
   b. Specificity
   c. Reversibility
   d. Assessment

5. The amount of overload needed to maintain or improve one's fitness level is NOT determined by:
   a. Time (duration)
   b. Intensity
   c. Frequency
   d. Specificity
6. Another term used for organizing your training into phases or cycles is:
   a. Specificity
   b. Skill training
   c. Periodization
   d. Overload

UNIT TWO

THE HEALTH BENEFITS OF PHYSICAL ACTIVITY

UNIT OBJECTIVES

By the end of this unit students should be able to:

- Describe the health benefits of physical activity
- Identify diseases which are associated with a sedentary lifestyle and the major risk factors for these diseases
- Realize regular physical activity in terms of disease prevention and healthy aging?
- Estimate physical activity needed for improved health benefits?
- Identify physical activities suitable for typical people, and how often should they exercise?

INTRODUCTION

Physical activity and physical fitness have been linked with health and longevity since ancient times. The earliest records of organized exercise used for health promotion are found in China,

around 2500 BC. However, it was the Greek physicians of the fifth and early fourth centuries BC who established a tradition of maintaining positive health through 'regimen'; the combination of correct eating and exercise. Hippocrates (460–370 BC), often called the Father of Modern Medicine, wrote all parts of the body which have a function, if used in moderation and exercised in labours in which each is accustomed, become thereby healthy, well-developed and age more slowly, but if unused and left idle they become liable to disease, defective in growth and age quickly.

This unit deals with physical activity trends, risk factors associated with chronic diseases, the role of regular physical activity in disease prevention and health, and physical activity guidelines and recommendations for improved health.

2.1. Physical Activity and Hypokinetic Diseases/ Conditions

Hypokinetic diseases are conditions related to inactivity or low levels of habitual activity.

The term "hypokinetic" was coined by Kraus and Raab in their book Hypokinetic Disease (Kraus & Raab, 1961). This term is now widely accepted and can be used to describe many of the diseases and conditions associated with inactivity and poor fitness such as those conditions outlined in Physical Activity and Health: A Report of the Surgeon General (USDHSS, 1996).

Our increased reliance on technology has substantially lessened work-related physical activity, as well as the energy expenditure required for activities of daily living like cleaning the house, washing clothes and dishes, mowing the lawn, and traveling to work. What would have once required an hour of physical work now can be accomplished in just a few seconds by pushing a button or setting a dial. As a result, more time is available to pursue leisure activities. The unfortunate fact is, however, that many individuals do not engage in physical activity during their leisure time.

Although the human body is designed for movement and strenuous physical activity, exercise is not a part of the average lifestyle. One cannot expect the human body to function optimally and to remain healthy for extended periods if it is abused or is not used as intended. Physical

inactivity has led to a rise in chronic diseases. Some experts believe that physical inactivity is the most important public health problem in the 21st century. Each year at least 1.9 million people die as a result of physical inactivity.

Data from the Aerobics Center Longitudinal Study (2009) indicated that low cardiorespiratory fitness accounts for substantially more deaths (16%) compared to other risk factors (i.e., obesity 2–3%; smoking 8–10%; high cholesterol 2–4%; diabetes 2–4%; and hypertension 8–16%). Individuals who do not exercise regularly are at a greater risk for developing chronic diseases such as coronary heart disease (CHD), hypertension, hypercholesterolemia, cancer, obesity, and musculoskeletal disorders (see figure 1.1).

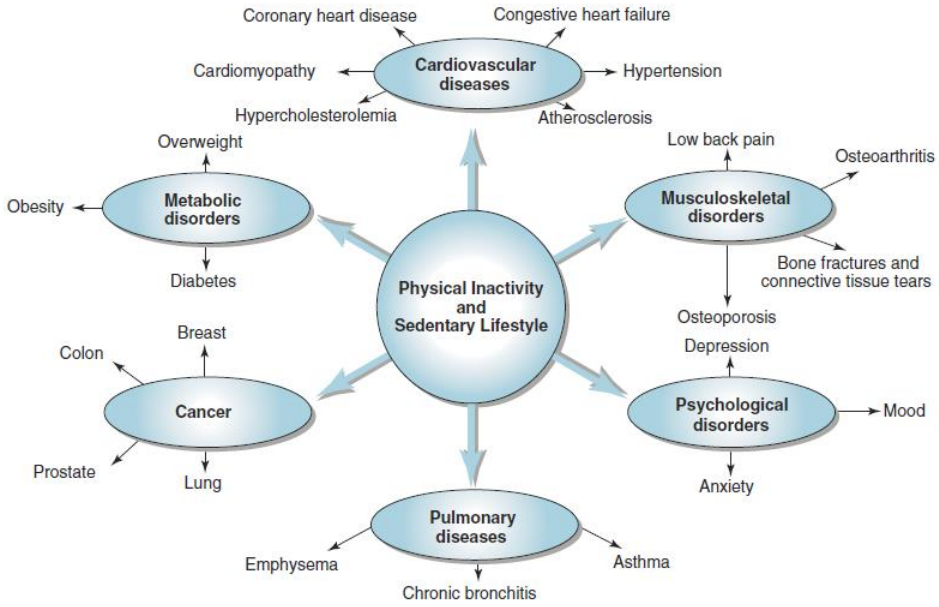

Figure 1.1 Role of physical activity and exercise in disease prevention and rehabilitation.

For years, exercise scientists and health and fitness professionals have maintained that regular physical activity is the best defense against the development of many diseases, disorders, and illnesses. In 1995, Center for Disease Control (CDC) and the American College of Sports Medicine (ACSM) recommended that every adult should accumulate 30 min or more of moderate-intensity physical activity on most, preferably all, days of the week.

Since 1995, new scientific evidence has increased our understanding of the benefits of physical activity for improved health and quality of life. In light of these findings, the American Heart Association (AHA) and the ACSM updated physical activity recommendations for healthy adults and older adults. These recommendations address how much and what kind of physical activity are needed to promote health and reduce the risk of chronic disease in adults. Table 1.1 summarizes the ACSM and AHA physical activity recommendations for adults. The recommended amounts of physical activity are in addition to routine activities of daily living (ADLs) such as cooking, shopping, and walking around the home or from the parking lot. The intensity of exercise is expressed in metabolic equivalents (METs). A MET is the ratio of the person's working (exercising) metabolic rate to the resting metabolic rate. One MET is defined as the energy cost of sitting quietly.

Table 1.1 Summary of the ACSM and AHA physical activity recommendations for adults

	AEROBIC ACTIVITY[a]			MUSCLE-STRENGTHENING ACTIVITY			FLEXIBILITY/ BALANCE ACTIVITY
Population group	**Duration[b] (min/day)**	**Intensity**	**Frequency (days/wk)**	**Sets**	**Intensity or # of exercises**	**Frequency (days/wk)**	
Healthy adults 18-65 yr	30 20	Moderate (3.0–6.0 METS) Vigorous (>6.0 METS)	Minimum 5 Minimum 3	1	8- to 12-RM; 8–10 exercises for major muscle groups	≥2 noncon-secutive days	No specific recommendation
Older adults >65 yr	30 20	Moderate (5 or 6 on 10 pt. scale) Vigorous (7 or 8 on 10 pt. scale)	Minimum 5 Minimum 3	1	10- to 15-RM; 8–10 exercises for major muscle groups; Moderate intensity (5 or 6 on 10 pt. scale) Vigorous intensity (7 or 8 on 10 pt. scale)	2 nonconsec-utive days	For flexibility at least 2 days per wk for at least 10 min each day; include balance exer-cises for those at risk for falls.

**Combinations of moderate and vigorous-intensity may be performed to meet recommendation (e.g., jogging 20 min on 2 days and brisk walking on 2 other days). *Multiple bouts of moderate intensity activity, each lasting at least 10 min, can be accumulated to meet the minimum duration of 30 min.*

Moderate-intensity aerobic activity (3.0–6.0 METs or 5 or 6 on a 10-point perceived exertion scale) is operationally defined as activity that noticeably increases heart rate and lasts more than 10 min (e.g., brisk walking for 15 min). Vigorous-intensity activity (>6.0 METs or 7 or 8 on a

10-point perceived exertion scale) causes rapid breathing and increases heart rate substantially (e.g., jogging).

For adults (18–65 yr) and older adults (>65 yr), the ACSM recommends a minimum of 30 min of moderate-intensity aerobic activity 5 days per week or 20 min of vigorous-intensity aerobic exercise 3 days per week. They also recommend moderate- to high-intensity (8- to 12-repetition maximum (RM) for adults and 10- to 15-RM for older adults) resistance training for a minimum of 2 nonconsecutive days per week. Balance and flexibility exercises are also suggested for older adults.

For substantial health benefits, adults should engage in aerobic exercise at least 150 min per week at a moderate intensity or 75 min per week at a vigorous intensity. In addition, adults and older adults should do muscle-strengthening activities at least 2 days per week. Children should do at least 60 min of physical activity every day. Most of the 60 min per day should be either moderate or vigorous aerobic activity and should include vigorous aerobic activities at least 3 days per week. Part of the 60 min or more of daily physical activity should be muscle strengthening activities (at least 3 days a week) and bone-strengthening activities (at least 3 days a week).

The term exercise deficit disorder (EDD) has been used to identify children who do not attain at least 60 min of moderate- to vigorous-intensity physical activity on a daily basis. Children having EDD may be susceptible to pathological processes associated with a physically inactive lifestyle.

Improvements in health benefits depend on the volume (i.e., combination of frequency, intensity, and duration) of physical activity. This is known as the dose-response relationship. Because of the dose-response relationship between physical activity and health, the ACSM/CDC physical activity recommendation states that “persons who wish to improve their personal fitness, reduce their risk for chronic diseases and disabilities, or prevent unhealthy weight gain will likely benefit by exceeding the minimum recommended amount of physical activity”.

Physical activity lowers the risk of hypokinetic conditions including dying prematurely, coronary artery disease, stroke, type 2 diabetes, metabolic syndrome, high blood lipid profile, cancers (colon, breast, lung, and endometrial), and hip fractures. It also reduces abdominal obesity and feeling of depression and anxiety. Physical activity helps in weight loss, weight maintenance and prevention of weight gain, prevention of fails, and improved functional health, improved cognitive function, increased bone density, and improved quality of sleep.

The Exercise and Physical Activity Pyramid illustrates a balanced plan of physical activity and exercise to promote health and to improve physical fitness (see figure 1.2). You should encourage your clients to engage in physical activities around the home and workplace on a daily basis to establish a foundation (base of pyramid) for an active lifestyle. They should perform aerobic activities a minimum of 3 days/wk; they should do weight-resistance exercises and flexibility or balance exercises at least 2 days per week. Recreational sport activities (middle levels of pyramid) are recommended to add variety to the exercise plan. High-intensity training and competitive sport (top of pyramid) require a solid fitness base and proper preparation to prevent injury; most adults should engage in these activities sparingly.

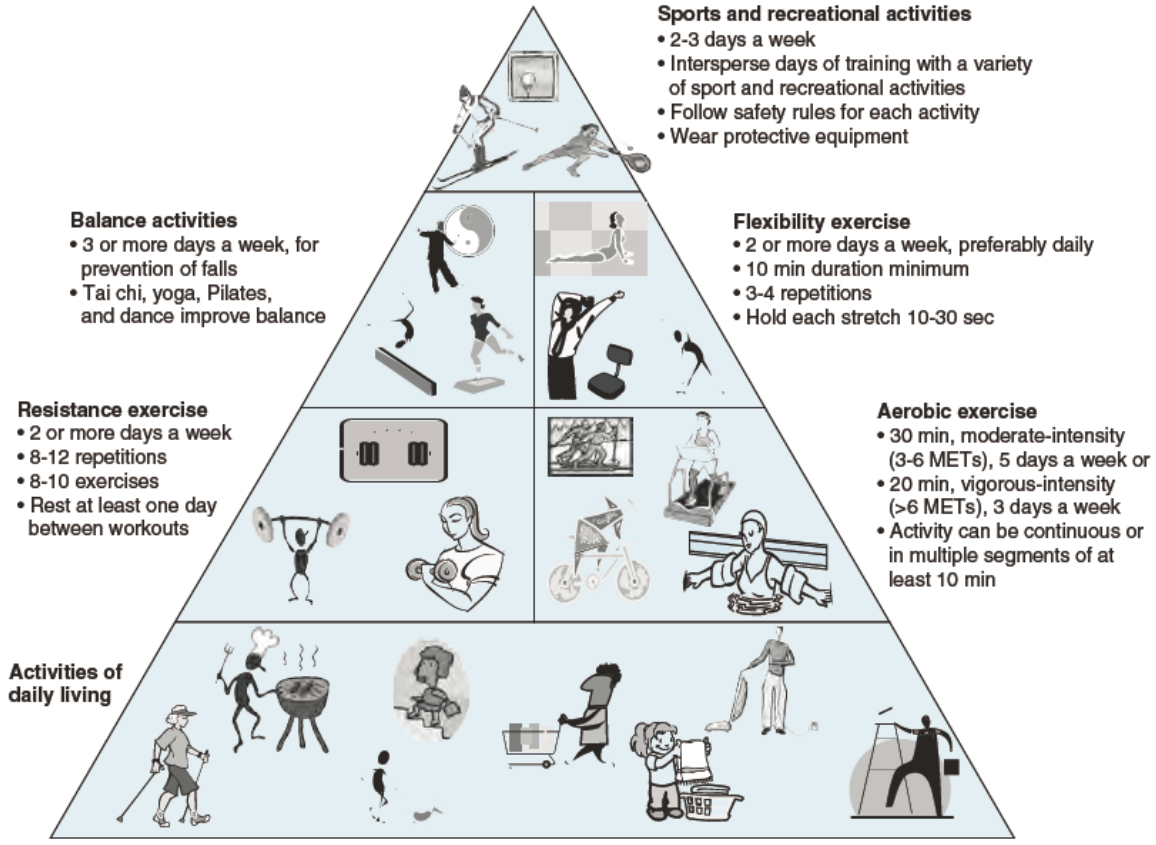
Sports and recreational activities
• 2-3 days a week
• Intersperse days of training with a variety of sport and recreational activities
• Follow safety rules for each activity
• Wear protective equipment
Balance activities
• 3 or more days a week, for prevention of falls
• Tai chi, yoga, Pilates, and dance improve balance
Flexibility exercise
• 2 or more days a week, preferably daily
• 10 min duration minimum
• 3-4 repetitions
• Hold each stretch 10-30 sec
Resistance exercise
• 2 or more days a week
• 8-12 repetitions
• 8-10 exercises
• Rest at least one day between workouts
Aerobic exercise
• 30 min, moderate-intensity (3-6 METs), 5 days a week or
• 20 min, vigorous-intensity (>6 METs), 3 days a week
• Activity can be continuous or in multiple segments of at least 10 min
Activities of daily living
• Daily physical activity is the base for physical fitness
• Try to be active for at least 30 min every day

Figure 1.2 The Exercise and Physical Activity Pyramid. Adapted from "Exercise and Activity Pyramid" Metropolitan Life Insurance Company, 1995.

Activity 2.1

Dear Student, discuss on the following questions with your partners.

4. *What type of relationship exhibited between physical activity and hypokinetic conditions?*
5. *Describe some of the major physical and mental health benefits of Exercise.*
6. *How do you plan to exercise*
   a. *What is the recommended minimum amount of daily physical activity for health?*
   b. *Give examples of moderate-intensity physical activity.*

2.2. Physical Activity and Cardiovascular Diseases

According to World Health Organization (WHO, 2011) cardiovascular disease (CVD) caused 17.3 million deaths (30%) worldwide in 2008, and it is projected to cause more than 26 million deaths by 2030. More than 80% of those cardiovascular deaths occurred in low- and middle-income countries.

2.2.1 Coronary Heart Disease (CHD)

Globally, coronary heart disease (CHD) accounts for more deaths than any other disease, with more than 7.6 million people dying from it in 2005 (WHO 2007). CHD is caused by a lack of blood supply to the heart muscle (myocardial ischemia) resulting from a progressive, degenerative disorder known as atherosclerosis.

Atherosclerosis is an inflammatory process involving a buildup of low-density lipoprotein (LDL) cholesterol, scavenger cells (monocytes), necrotic debris, smooth muscle cells, and fibrous tissue. This is how plaques form in the intima, or inner lining of the medium- and large-sized arteries throughout the cardiovascular system. As more lipids and cells gather in the plaques, they bulge into the arterial lumen. In the heart, these bulging plaques restrict blood flow to the myocardium and may produce angina pectoris, which is a temporary sensation of tightening and heavy pressure in the chest and shoulder region. A myocardial infarction, or heart attack, can occur if a blood clot (thrombus) or ruptured plaque obstructs the coronary blood flow. In this case, blood flow through the coronary arteries is usually reduced by more than 80%. The portion of the myocardium supplied by the obstructed artery may die and eventually be replaced with scar tissue.

Coronary Heart Disease Risk Factors*:* Epidemiological research indicates that many factors are associated with the risk of CHD. The greater the number and severity of risk factors, the greater the probability of CHD. The positive risk factors for CHD are:

- Age,
- Family History,
- Hypercholesterolemia,
- Hypertension,
- Tobacco use,

- Diabetes Mellitus or Prediabetes,
- Overweight and Obesity, and
- Physical Inactivity.

An increased level (≥60 mg · dl^{-1}) of high-density lipoprotein cholesterol, or HDL-cholesterol (HDLC), in the blood decreases CHD risk. If the HDL-C is high, you should subtract one risk factor from the sum of the positive factors when assessing CHD risk.

***Physical Activity and Coronary Heart**:* Disease Approximately 6% of CHD deaths worldwide can be attributed to a lack of physical activity (WHO, 2010). Physically active people have lower incidences of myocardial infarction and mortality from CHD and tend to develop CHD at a later age compared to their sedentary counterparts. Individuals who exercise regularly reduce their relative risk of developing CHD by a factor of 1.5 to 2.4. Leading a physically active lifestyle may prevent 20% to 35% of cardiovascular diseases. Physical activity exerts its effect independently of smoking, hypertension, hypercholesterolemia, obesity, diabetes, and family history of CHD.

2.2.2 Hypertension

Hypertension, or high blood pressure, is a chronic, persistent elevation of blood pressure that is clinically defined as a systolic pressure ≥140 mmHg or a diastolic pressure ≥90 mmHg. Individuals taking antihypertensive medicine also have this diagnosis. Prehypertension is a term used to describe individuals with a systolic pressure of 120 to 139 mmHg, a diastolic pressure of 80 to 89 mmHg, or both. A clear link exists between hypertension and cardiovascular disease.

WHO (2011) identified hypertension as the leading cardiovascular risk factor, attributing 13% of deaths worldwide to high blood pressure. Hypertension is also the primary risk factor for all types of stroke. About 15% to 40% of the global adult population has hypertension.

Regular physical activity prevents hypertension and lowers blood pressure in younger and older adults who are normotensive, prehypertensive, or hypertensive. Compared to normotensive individuals, training-induced changes in resting systolic and diastolic blood pressures (5–7

mmHg) are greater for hypertensive individuals who participate in endurance exercise. However, even modest reductions in blood pressure (2–3 mmHg) by endurance or resistance exercise training decrease CHD risk by 5% to 9%, stroke risk by 8% to14%, and all-cause mortality by 4% in the general population (Pescatello et al. 2004). In a position paper on exercise and hypertension (Pescatello et al. 2004), the ACSM endorsed the following exercise prescription to lower blood pressure in adults with hypertension (see "ACSM's Exercise Prescription for Individuals With Hypertension" below).

Exercise Prescription for Individuals with Hypertension (ACSM, 2013)
Mode: Primarily endurance activities supplemented by resistance exercises Intensity: Moderate-intensity endurance (40–60% VO_2R)* and resistance training (60–80% 1-RM) **Duration:** 30–60 min or more of continuous or accumulated aerobic physical activity per day, and a minimum of one set (8–12 reps) of resistance training exercises for each major muscle group. **Frequency:** Most, preferably all, days of the week for aerobic exercise; 2 or 3 days/wk for resistance raining. **VO2R is the difference between the maximum and the resting rate of oxygen consumption.*

2.2.3 Hyper-cholesterolemia and Dyslipidemia

Hypercholesterolemia, is an elevation of total cholesterol (TC) in the blood, is associated with increased risk for CVD. Hypercholesterolemia is also referred to as hyperlipidemia, which is an increase in blood lipid levels; dyslipidemia refers to an abnormal blood lipid profile. Approximately 18% of strokes and 56% of heart attacks are caused by high blood cholesterol (WHO**,** 2002). Age, gender, family history, alcohol, smoking are risk factors for hypercholesterolemia and regular activity reduced the chance of getting hypercholesterolemia and hyslipidemia.

LDLs, HDLs, and TC: Cholesterol is a waxy, fatlike substance found in all animal products (meats, dairy products, and eggs). The body can make cholesterol in the liver and absorb it from the diet. Cholesterol is essential to the body, and it is used to build cell membranes, to produce sex hormones, and to form bile acids necessary for fat digestion. Lipoproteins are an essential part of the complex transport system that exchanges lipids among the liver, intestine, and peripheral tissues.

Lipoproteins are classified by the thickness of the protein shell that surrounds the cholesterol. The four main classes of lipoproteins are chylomicron, derived from the intestinal absorption of triglycerides (TG); very low-density lipoprotein (VLDL), made in the liver for the transport of triglycerides; low-density lipoprotein (LDL), a product of VLDL metabolism that serves as the primary transporter of cholesterol; and high-density lipoprotein (HDL), involved in the reverse transport of cholesterol to the liver. The molecules of LDL are larger than those of HDL and therefore precipitate in the plasma and are actively transported into the vascular walls. Excess LDL-cholesterol (LDL-C) stimulates the formation of plaque on the intima of the coronary arteries.

Plaque formation reduces the cross-sectional area and obstructs blood flow in these arteries, eventually producing a myocardial infarction. Therefore, LDL-C values less than 100 $mg.dl^{-1}$ are considered optimal for reducing CVD and CHD risk. The smaller HDL molecules are suspended in the plasma and protect the body by picking up excess cholesterol from the arterial walls and delivering it to the liver where it is metabolized.

Individuals with low HDL-C or high TC levels (dyslipidemia) have a greater risk of heart attack. Those with lower HDL-C (<37 $mg.dl^{-1}$) are at higher risk regardless of their TC level. This fact emphasizes the importance of screening for both TC and HDL-C in adults.

Physical Activity and Lipid Profiles: Regular physical activity, especially habitual aerobic exercise, positively affects lipid metabolism and lipid profiles. Cross-sectional comparisons of lipid profiles in physically active and sedentary women and men suggest that physical fitness is inversely related to TC and the TC/HDL-C ratio (Shoenhair and Wells 1995). The research on the effect of resistance training on cholesterol levels continues to remain inconclusive.

2.2.4 Diabetes Mellitus

Diabetes is a global epidemic. More than 346 million people worldwide have the disease (WHO, 2011). Factors linked to this epidemic include urbanization, aging, physical inactivity, unhealthy diet, and obesity. At least 65% of people with diabetes mellitus die from some form of heart or blood vessel disease (AHA, 2008). Diabetes is a major contributor toward the development of CHD and stroke. Also, diabetes is among the leading causes of kidney failure; 10% to 20% of people with diabetes die of kidney failure (WHO, 2008).

Prediabetes, in addition to being a positive risk factor for CVD, is a medical condition identified by fasting blood glucose or glycated hemoglobin (HbA1c) levels that are above normal values but lower than the threshold for a diagnosis of diabetes (CDC, 2011). HbA1c is an indicator of the average blood glucose over the past 2 to 3 months. Fortunately, prediabetes appears to respond favorably to weight loss and increases in physical activity.

Type 1, formerly referred to as insulin-dependent diabetes mellitus (IDDM), usually occurs before age 30 but can develop at any age. Type 2, previously known as non-insulin-dependent diabetes mellitus (NIDDM), is more common; 90% of individuals diagnosed with diabetes mellitus worldwide have type 2 diabetes (WHO, 2011). Age, gender, family history, calorie intake, physical inactivity are risk factors for developing diabetes.

Type 1 diabetes may be caused by autoimmune, genetic, or environmental factors, but the specific cause is unknown. Unfortunately, there is no known way to prevent type 1 diabetes (CDC, 2011). Healthy nutrition and increased physical activity, however, can reduce the risk of type 2 diabetes by as much as 67% in high-risk individuals (Sanz, Gautier, and Hanaire 2010). Nearly 90% of cases of type 2 diabetes worldwide may be related to obesity (Wagner and Brath 2012).

The effect of exercise alone as an intervention for people with type 2 diabetes is not well researched. However, exercise (30–120 min, 3 days/wk for 8 wk) produced clinically significant improvements in HbA1c and reduced visceral and subcutaneous adipose tissue stores in people with type 2 diabetes. Additionally, no adverse effects or diabetic complications resulting from

exercise were reported (Thomas et al. 2006). Research that associates physical activity with weight loss, fat loss, and glycemic control suggests that regular physical activity reduces one's risk of developing type 2 diabetes. Both resistance and aerobic exercise alone or in combination improve HbA1c values in people with type 2 diabetes. The frequency of exercise is crucial for those with diabetes. If daily exercise is not possible, it should not be skipped 2 days in a row. Dear Students, for specific guidelines for prescribing exercise programs for people who have type 1 and type 2 diabetes please refer ACSM Guideline (2014).

2.2.5 Obesity and Overweight

In clinical guidelines established by the Obesity Education Initiative Task Force of the National Institutes of Health and National Heart, Lung, and Blood Institute (1998), adult overweight and obesity are classified using the body mass index (BMI) (BMI = weight [kg] / height squared [m2]). Individuals with a BMI between 25 and 29.9 kg/m2 are classified as overweight; those with a BMI of 30 kg/m2 or more are classified as obese. While WHO (2012) acknowledges the utility of BMI as a simple index of obesity, they also caution that it cannot account for the relative fatness of different individuals having the same BMI. Actually, they define overweight and obesity as having *abnormal or excessive fat accumulation that may impair health*. Regardless, overweight and obesity ranks as the fifth leading risk factor for death worldwide (WHO, 2012).

Globally, more than 1 in every 10 adults is obese (WHO, 2012). Originally overweight and obesity were considered to be problems of high-income countries; now, these conditions are on the rise in the low- and middle-income countries (WHO, 2012).

Childhood obesity (≥95th percentile for sex and age) is also a global problem. Overweight adolescents have a 70% chance of becoming overweight adults; this increases to 80% if one or both parents are overweight or obese (AHA, 2012). The World Health Organization (2012) reported that nearly 35 million children living in developing countries are overweight (85th percentile ≤ BMI < 95th percentile for age and gender). In developed countries, approximately 8 million children are overweight. Age, gender, family history, cholesterol intake, and physical inactivity are the major factors associated with increased risk of obesity.

Excess body weight and fatness pose a threat to both the quality and duration of one's life. Obese individuals have a shorter life expectancy and greater risks of CHD, stroke, dyslipidemia, hypertension, diabetes mellitus, certain cancers, osteoarthritis, sleep apnea, abnormal menses, and infertility (National Heart, Lung, and Blood Institute, 2012). Although obesity is strongly associated with CHD risk factors such as hypertension, glucose intolerance, and hyperlipidemia, the contribution of obesity to CHD appears to be independent of the influence of obesity on these risk factors.

Restricting caloric intake and increasing caloric expenditure through physical activity and exercise are effective ways of reducing body weight and fatness while normalizing blood pressure and blood lipid profiles.

2.2.6 Metabolic Syndrome

Metabolic syndrome refers to a combination of CVD risk factors associated with hypertension, dyslipidemia, insulin resistance, and abdominal obesity. According to clinical criteria adopted by the National Cholesterol Education Program (2001), individuals with three or more CVD risk factors are classified as having metabolic syndrome

Age and BMI directly relate to metabolic syndrome (National Cholesterol Education Program 2001). The prevalence of this syndrome is higher (>40%) for older (>60 yr) adults than for younger (20–29 yr) adults (7%). Also, the prevalence of metabolic syndrome is much higher for obese (BMI > 30 kg/m2) individuals (~50%) than for normal weight (BMI ≤ 25 kg/m2) individuals (6.2%). Lifestyle must be modified in order to manage metabolic syndrome. The combination of healthy nutrition and increased physical activity is an effective way to increase HDL-C and to reduce blood pressure, body weight, triglycerides, and blood glucose levels.

2.2.7 Aging

A sedentary lifestyle and lack of physical activity reduce life expectancy by predisposing the individual to aging-related diseases and by influencing the aging process itself. With aging, a progressive loss of physiological and metabolic functions occurs; however, biological aging may

differ considerably among individuals due to variability in genetic and environmental factors that affect oxidative stress and inflammation. Telomeres are repeated DNA sequences that determine the structure and function of chromosomes. With aging and diseases associated with increased oxidative stress (e.g., CHD, diabetes mellitus, osteoporosis, and heart failure), telomere length decreases. Thus, regular exercise benefits in retarding the aging process and diminishing the risk of aging-related diseases.

Activity 2.2

Dear Student, discuss on the following questions with your partners.

1. *Define obesity and overweight relative to BMI.*
2. *Define metabolic syndrome and identify its relationship to CVD.*
3. *What types of exercise are effective for counteracting bone loss due to aging? Explain how chronic adherence to moderate intensity physical activity affects the aging process.*

2.3 Physical Activity and Postural Deformity

? *What Is Posture?*

Posture is the position from which movement begins and ends. Having proper postural alignment enables the body to perform movements quicker with less joint and muscular strain.

? *Why Good Posture Is Important*

The body is designed to work at the most economical level, thus saving energy for future use. We spend more energy maintaining misaligned posture, which can cause muscle and joint pain. We compromise our body's integrity by not maintaining proper posture, resulting in decreased circulation; leading to varicose veins, muscle pain, joint pain, and many other conditions.

Women in general tend to develop poor posture because of many factors. They often have more clerical and computer oriented jobs that require sitting in a chair, eyeing a computer screen for long periods of time. They also wear high-heeled shoes, which lead to an alteration and compensation of their posture. The development of breast tissue or the augmentation of breasts can lead to many postural changes. Women also have less musculature to maintain proper alignment, leading to rounded shoulders, forward head posture, hyper-extended knees, and increased thoracic and lumbar curves. Men can also develop all of these postural problems but at a different degree and rate depending on their situation.

To improve your posture and reduce structural damage, you should adhere to a corrective postural exercise program. This simple yet productive program will combat the effects of bad posture and help alleviate joint and muscle pain. Exercises for correcting posture:

- Prone Cobra
- Axial Extension Trainer
- Wall Leans
- Cervical Extension using a blood pressure cuff

2.3.1 Musculoskeletal Diseases and Disorders

Diseases and disorders of the musculoskeletal system, such as osteoporosis, osteoarthritis, bone fractures, connective tissue tears, and low back syndrome, are also related to physical inactivity and a sedentary lifestyle. Osteoporosis is a disease characterized by the loss of bone mineral content and bone mineral density due to factors such as aging, amenorrhea, malnutrition, menopause, and physical inactivity. It is becoming a major health issue, with an osteoporotic fracture occurring every 3 seconds worldwide. Wrist fractures precede the most common osteoporotic fracture, vertebral fractures.

However, hip fractures are the most devastating (International Osteoporosis Foundation 2009). Although osteoporotic fractures may occur in any bone, a hip fracture is recognized as a

surrogate measure of the health care burden and expense due to osteoporosis, especially for men and women ≥50 yr.

Osteopenia, or low bone mineral mass, is a precursor to osteoporosis. More than one of every two adults aged 50 or older has either osteoporosis or osteopenia (National Osteoporosis Foundation, 2004).

Adequate calcium intake, vitamin D intake, and regular physical activity help counteract age-related bone loss. ACSM suggests the following exercise prescription to help counteract bone loss due to aging and preserve bone health during adulthood.

Exercise Prescription for Preserving Bone Health of Adults

Mode: Weight-bearing endurance activities (e.g., stair climbing, jogging), activities that involve jumping (e.g., basketball, plyometrics), and resistance training

Intensity: Moderate to high, in terms of bone-loading forces

Frequency: 3–5 times per week for weight-bearing endurance activities; 2 or 3 times per week for resistance exercise

Duration: 30–60 min/day of a combination of weight-bearing endurance activities, activities that involve jumping, and resistance training that targets all major muscle groups

Low back pain afflicts millions of people each year. More than 80% of all low back problems are produced by muscular weakness or imbalance caused by a lack of physical activity (see table 1.3). If the muscles are not strong enough to support the vertebral column in proper alignment, poor posture results and low back pain develops. Excessive weight, poor flexibility, and improper lifting habits also contribute to low back problems. While some risks of associated with low back pain are not modifiable, such as gender and age, lifestyle behavior such as smoking, physical inactivity, flexibility, and muscular strength and endurance can all be improved. Because the origin of low back problems is often functional rather than structural, in many cases, the problem can be corrected through an exercise program that develops strength and flexibility in the appropriate muscle groups. Also, people who remain physically active throughout life

retain more bone, ligament, and tendon strength; therefore, they are less prone to bone fractures and connective tissue tears.

Activity 2.3

Dear Student, discuss on the following questions with your partners.

1. *Explain the relationship between physical inactivity and postural deformity?*
2. *Describe the relationship between physical inactivity musculoskeletal disorder and low back pain.*

UNIT SUMMARY

- Major chronic diseases associated with a lack of physical activity are CVDs, diabetes, obesity, and musculoskeletal disorders.
- Cardiovascular diseases are responsible for 30% of all deaths worldwide.
- The positive risk factors for CHD are the following: age, family history, dyslipidemia, hypertension, tobacco use, prediabetes or glucose intolerance, obesity, and physical inactivity.
- The prevalence of obesity is on the rise, especially in developed countries; two of every three adults and more than one of every three adolescents and children are overweight or obese.

- BMI is used to identify and classify individuals as overweight or obese. Cutoff values for obesity, however, may vary depending on ethnicity.
- Metabolic syndrome is a term used to describe individuals who have three or more cardiovascular disease risk factors.
- Osteoporosis and low back syndrome are musculoskeletal disorders afflicting millions of people each year.
- To benefit health and prevent disease, every adult should accumulate a minimum of 150 min/wk of moderate-intensity physical activity or 75 min/wk of vigorous-intensity physical activity. For additional health benefits, increase physical activity to 300 min/wk and 150 min/wk, respectively, for moderate- and vigorous-intensity exercise.

SELF-TEST EXERCISE

1. What diseases are associated with a sedentary lifestyle, and what are the major risk factors for these diseases?
2. What are the benefits of regular physical activity in terms of disease prevention and healthy aging?
3. How does physical activity improve health?
4. How much physical activity is needed for improved health benefits?
5. What kinds of physical activities are suitable for typical people, and how often should they exercise?

UNIT THREE

MAKING WELL-INFORMED FOOD CHOICES

UNIT OBJECTIVES

By the end of this unit students should be able to:-

- Summarize the basics of nutrition
- Define macronutrients and micronutrients
- Categorize and describe the body's sources of energy

- Analyze intake of nutrition and make appropriate changes for sound eating practices
- Realize the management of nutrition for better physical performance

INTRODUCTION

Regular exercise taxes every cell and every system in your body: your muscles, joints, ligaments, tendons, respiratory, circulatory and immune systems all have to work harder when you exercise. Eating a healthy diet can help minimize the damage caused by exercise and help your body rebuild itself even stronger. Your daily diet needs to meet the tough demands of your training programme as well as keep you healthy. To help you make the right food choices, this unit explains the basis of a good training diet, what each nutrient does, how much you need and how you can achieve your ideal intake.

3.1 Sound Eating Practices

? What is Nutrition? And what is Nutrient?

Nutrition can be defined as the science of the action of food, beverages, and their components in biological systems. A nutrient is a compound that provides a needed function in the body. Nutrients can be further classified based on the amount needed in the body. Macronutrients are the nutrients the body needs in larger amounts. Micronutrients are also important nutrients, but ones the body needs in smaller amounts.

3.1.1 Macronutrients

- *Carbohydrates*: The word *carbohydrate* literally means "hydrated carbon," or carbon with water. Thus, it is no surprise that carbohydrates are made up of carbon, hydrogen, and oxygen. Sucrose (table sugar) is an example of a commonly consumed carbohydrate. Some dietary examples of carbohydrates are whole-wheat bread, oatmeal, rice, sugary snacks/drinks, and pasta.

- *Proteins*: Like carbohydrates, proteins are comprised of carbon, hydrogen, and oxygen, but they also contain nitrogen. Several dietary sources of proteins include nuts, beans/legumes, skim milk, egg whites, and meat.
- *Lipids*: Lipids consist of fatty acids, triglycerides, phospholipids, and sterols (cholesterol). Lipids are also composed of carbon, hydrogen, and oxygen. Some dietary sources of lipids include oils, butter, and egg yolks.
- *Water*: Water is made up of hydrogen and oxygen and is the only macronutrient that provides no energy.

3.1.2 Micronutrients

- *Vitamins*: These compounds are essential for normal physiologic processes in the body.
- *Minerals*: Minerals are the elements (think periodic table) that are essential for normal physiologic processes in the body.

Activity 3.1

Dear Student! Try to remember the food you usually consume and list them in the following category of nutrient.

Macronutrients	***Micronutrients***

3.1.3 Calories (Food Energy)

Food energy is measured in kilocalories (kcals), commonly referred to as calories. Although technically incorrect, this terminology is so familiar that it will be used throughout this course. A kilocalorie is the amount of energy needed to raise 1 kilogram of water 1 degree Celsius. A food's kilocalories are determined by putting the food into a bomb calorimeter and determining the energy output: Energy = Measurement of Heat Produced. Below is a picture of a bomb calorimeter and a link to a video showing how one is used. The number of kilocalories per gram for each nutrient is shown below:

Table 3.1:- Amount of calories obtained from nutrients

Nutrient	*Energy (kcal/g)*
Carbohydrate	*4*
Protein	*4*
Lipids	*9*
Water	*0*
Vitamins	*0*
Minerals	*0*

As the table 3.1 above illustrates, only carbohydrates, protein, and lipids provide energy. However, there is another dietary energy source that is not a nutrient— alcohol. To emphasize, alcohol is *not* a nutrient, but it does provide 7 kilocalories of energy per gram.

Knowing the number of calories in each nutrient allows a person to calculate/estimate the amount of calories contained in any food consumed. Your daily calorie needs will depend on your genetic make-up, age, weight, body composition, your daily activity and your training programme. It is possible to estimate the number of calories you need daily from your body weight (BW) and your level of daily physical activity.

Step 1: Estimate your Basal Metabolic Rate (BMR)

As a rule of thumb, BMR uses 22 calories for every kg of a woman's body weight and 24 calories per kg of a man's body weight.

Women: BMR = weight in kg x 22
Men: BMR = weight in kg x 24

Step 2: Work out your Physical Activity Level (PAL)

This is the ratio of your overall daily energy expenditure to your BMR; a rough measure of your lifestyle activity.

☞ *Mostly inactive or sedentary (mainly sitting): 1.2*

- *Fairly active (include walking and exercise 1–2 x week): 1.3*
- *Moderately active (exercise 2–3 x weekly): 1.4*
- *Active (exercise hard more than 3 x weekly): 1.5*
- *Very active (exercise hard daily): 1.7*

Step 3: Multiply your BMR by your PAL to work out your Daily Calorie Needs

Daily calorie needs = BMR x PAL

This figure gives you a rough idea of your daily calorie requirement to maintain your weight. If you eat fewer calories, you will lose weight; if you eat more then you will gain weight.

- *Your BMR is the number of calories you burn at rest (to keep your heart beating, your lungs breathing, to maintain your body temperature, etc). It accounts for 60–75% of the calories you burn daily. Generally, men have a higher BMR than women.*
- *Physical activity includes all activities from doing the housework to walking and working out in the gym. The number of calories you burn in any activity depends on your weight, the type of activity and the duration of that activity.*

Activity 3.2

Dear Student, discuss on the following questions with your partners.

1. *Where do you get energy for your body function?*
2. *How many calories do you need per day?*
3. *Estimate daily energy needs for an active 60 kg woman and a 70 kg sedentary man.*
4. *Estimate daily energy needs for an active 60 kg man to gain weight and a 70 kg sedentary woman to lose weight.*

I. Carbohydrates

Carbohydrate is an important fuel for exercise. It is stored as glycogen in your liver and muscles, and must be re-stocked each day. Approximately 100 g glycogen (equivalent to 400 kilocalories)

may be stored in the liver, and up to 400 g glycogen (equivalent to 1600 kilocalories) in muscle cells. The purpose of liver glycogen is to maintain steady blood sugar levels. When blood glucose dips, glycogen in the liver breaks down to release glucose into the bloodstream. The purpose of muscle glycogen is to fuel physical activity.

The more active you are, the higher your carbohydrate needs. Guidelines for daily intakes are about 5–7 g per kg of body weight per day for moderate duration/low intensity daily training. Those who do moderate–heavy endurance training should consume 7–10 g per kg body weight per day; and those training more than 4 hours per day are advised to consume 10 g or more per kg body weight per day.

To promote post-exercise recovery, the 2003 IOC Consensus conference recommends consuming 1 g per kg BW per hour during the first four hours following exercise. If you plan to train again within 8 hours, it is important to begin refueling as soon as possible after exercise. Moderate and high glycaemic index (GI) carbohydrates will promote faster recovery during this period. However, for recovery periods of 24 hours or longer, the type and timing of carbohydrate intake is less critical, although you should choose nutrient-dense sources wherever possible.

Carbohydrates have become, surprisingly, quite controversial. Some people passionately extol the merits of carbohydrates, while others berate them as nutritional assassins. However, it is important to understand that carbohydrates are a diverse group of compounds that have a multitude of effects on bodily functions. Thus, trying to make blanket statements about carbohydrates is not a good idea.

During exercise lasting longer than 60 minutes, consuming 20–60 g carbohydrate per hour helps maintain your blood glucose level, delay fatigue and increase your endurance. Choose high GI carbohydrates (e.g. sports drinks, energy gels and energy bars, bananas, fruit bars, cereal or breakfast bars), which convert into blood sugar rapidly.

Food manufacturers are always searching for cheaper ways to produce their products. One extremely popular method for reducing costs is the use of high-fructose corn syrup as an alternative to sucrose. High-fructose corn syrup is approximately 50% glucose and 50% fructose,

which is the same as sucrose. Nevertheless, because increased consumption of high-fructose corn syrup has coincided with increased obesity, a lot of controversy surrounds its use. Alternative sweeteners are simply alternatives to sucrose and other mono-and disaccharides that provide sweetness.

Activity 3.4

Dear Student, would you list and explain types of carbohydrates and their importance for ordinary person as well as athletes? Please try to illustrate it by providing food examples you most familiar with.

II. Protein

Protein is another major macronutrient that, like carbohydrates, consists of small repeating units. But instead of sugars, proteins are made up of amino acids. Proteins can be classified as either complete or incomplete. Amino acids from proteins form the building blocks for new tissues and the repair of body cells. They are also used for making enzymes, hormones and antibodies. Protein also provides a (small) fuel source for exercising muscles.

Athletes have higher protein requirements than non-active people. Extra protein is needed to compensate for the increased muscle breakdown that occurs during and after intense exercise, as well as to build new muscle cells. The IOC and IAAF both recommend between 1.2 and 1.7 g protein/kg BW/day for athletes or 84–119 g daily for a 70 kg person. This is considerably more than a sedentary person, who requires 0.75 g protein/kg BW daily.

Some athletes eat high protein diets in the belief that extra protein leads to increased strength and muscle mass, but this isn't true, it is stimulation of muscle tissue through exercise, not extra protein that leads to muscle growth. As protein is found in so many foods, most people, including athletes eat a little more protein than they need. This isn't harmful, the excess is broken down into urea (which is excreted) and fuel, which is either used for energy or stored as fat if your calorie intake exceeds your output.

Several studies have found that carbohydrate and protein eaten together immediately after exercise enhances recovery and promotes muscle building. This does not mean additional food or supplements. It means that you should space out some of the protein and carbohydrates you currently have in your diet and consume it after workouts.

III. Fat

Some fat is essential, it makes up part of the structure of all cell membranes, your brain tissue, nerve sheaths, bone marrow and it cushions your organs. Fat in food also provides essential fatty acids, the fat-soluble vitamins A, D and E, and is an important source of energy for exercise. The IOC does not make a specific fat recommendation, but the American College of Sports Medicine (ACSM) and American Dietetic Association recommend fat provides 20–25% of calorie intake for athletes compared with the UK government recommendation of 33% for the general population. Therefore, about 20–33% of the calories in your diet should come from fat.

'Bad' fats (saturated and trans fats) should be kept to a minimum (the UK government recommends less than 10% of calories), with the majority coming from 'good' (unsaturated) fats. Omega-3s may be particularly beneficial for athletes as they help increase the delivery of oxygen to muscles, improve endurance and may speed recovery, reduce inflammation and joint stiffness.

There is neither bad nor good cholesterol, despite the common use of these descriptions in reference to LDL and HDL, respectively. Cholesterol is cholesterol. HDL and LDL contain cholesterol but are actually lipoproteins. It is not necessary to include cholesterol in your diet because our bodies have the ability to synthesize the required amounts.

IV. Fiber

The simplest definition of fiber is indigestible matter. Indigestible means that it survives digestion in the small intestine and reaches the large intestine. There are the three major fiber classifications:

- *Dietary fiber*: This type of fiber contains both non-digestible carbohydrates and lignin and is always intrinsic and intact in plants.
- *Functional fiber:* This type of fiber contains non-digestible carbohydrates only and can be isolated, extracted, or synthesized. Functional fiber can be from plants or animals and produces beneficial physiological effects in humans.
- *Total Fiber*: Fiber that contains both dietary fiber and functional fiber.

Activity 3.4

Dear Student, discuss briefly on the following questions with your partners.

1. *What foods are the best sources of protein?*
2. *What do protein do for our body?*
3. *What advantages could you possibly obtain by consuming more fiber foods?*
4. *Most of the time people are afraid of eating foods constituted with much more fat. Explain why do you think they get threatend by those type of food options. Do you think it is right to afraid and get ride of them?*

V. Vitamins

Vitamins are organic compounds found in foods and are a necessary part of the biochemical reactions in the body. They are involved in a number of processes, including mineral and bone metabolism, and cell and tissue growth, and they act as cofactors for energy metabolism. The B vitamins play the largest role of any vitamins in metabolism.

You get most of your vitamins through your diet, although some can be formed from the precursors absorbed during digestion. For example, the body synthesizes vitamin A from the β-carotene in orange vegetables like carrots and sweet potatoes. Vitamins are either fat-soluble or water-soluble. Fat-soluble vitamins A, D, E, and K, are absorbed through the intestinal tract with lipids in chylomicrons. Vitamin D is also synthesized in the skin through exposure to sunlight.

Because they are carried in lipids, fat-soluble vitamins can accumulate in the lipids stored in the body. If excess vitamins are retained in the lipid stores in the body, hypervitaminosis can result.

Water-soluble vitamins, including the eight B vitamins and vitamin C, are absorbed with water in the gastrointestinal tract. These vitamins move easily through bodily fluids, which are water based, so they are not stored in the body. Excess water-soluble vitamins are excreted in the urine. Therefore, hypervitaminosis of water-soluble vitamins rarely occurs, except with an excess of vitamin supplements.are stored in the skeleton and necessary for the hardening of bones. Most minerals are ionized, and their ionic forms are used in physiological processes throughout the body. Sodium and chloride ions are electrolytes in the blood and extracellular tissues, and iron ions are critical to the formation of hemoglobin. There are additional trace minerals that are still important to the body's functions, but their required quantities are much lower.

Like vitamins, minerals can be consumed in toxic quantities (although it is rare). A healthy diet includes most of the minerals your body requires, so supplements and processed foods can add potentially toxic levels of minerals.

VI. Minerals

Minerals in food are inorganic compounds that work with other nutrients to ensure the body functions properly. Minerals cannot be made in the body; they come from the diet. The amount of minerals in the body is small, only 4 percent of the total body mass and most of that consists of the minerals that the body requires in moderate quantities: potassium, sodium, calcium, phosphorus, magnesium, and chloride.

The most common minerals in the body are calcium and phosphorous, both of which are stored in the skeleton and necessary for the hardening of bones. Most minerals are ionized, and their ionic forms are used in physiological processes throughout the body. Sodium and chloride ions are electrolytes in the blood and extracellular tissues, and iron ions are critical to the formation of hemoglobin. There are additional trace minerals that are still important to the body's functions, but their required quantities are much lower.

Like vitamins, minerals can be consumed in toxic quantities (although it is rare). A healthy diet includes most of the minerals your body requires, so supplements and processed foods can add potentially toxic levels of minerals.

VII. Water

You should ensure you are hydrated before starting training competition and aim to minimise dehydration during exercise. Dehydration can result in reduced endurance and strength, and heat related illness. The IOC advises matching your fluid intake to your fluid losses as closely as possible and limiting dehydration to no more than 2% loss of body weight (e.g. a body weight loss of no more than 1.5 kg for a 75 kg person).

Additionally, the IAAF cautions against overhydrating yourself before and during exercise, particularly in events lasting longer than 4 hours. Constantly drinking water may dilute your blood so that your sodium levels fall. Although this is quite rare it is potentially fatal. The American College of Sports Medicine advise drinking when you're thirsty or drinking only to the point at which you're maintaining your weight, not gaining weight. Sports drinks are better than water during intense exercise lasting more than 60 minutes because their sodium content will promote water retention and prevent hyponatraemia.

Activity 3.5

Dear Student, discuss briefly on the following questions with your partners.

1. *Distinguish between fat – soluble and water – soluble vitamins? which do you think recommendable for better health gain?*
2. *Which minerals are important for the body if consumed with moderate amount?*
3. *What is dehydration? How do we prevent yourself from getting dehydrated*

3.2 Nutrition and Physical Performance

There is universal scientific consensus that diet affects performance. A well-planned eating strategy will help support any training programme, whether you are training for fitness or for

competition; promote efficient recovery between workouts; reduce the risk of illness or overtraining, and help you to achieve your best performance.

Of course, everyone has different nutritional needs and there is no single diet that fits all. Some athletes require more calories, protein or vitamins than others; and each sport has its unique nutritional demands. But it is possible to find broad scientific agreement as to what constitutes a healthy diet for sport generally.

3.2.1 Nutrition before Training Exercise

What you eat and drink the day before and during the several hours before your workout dictates how much energy you'll have for training and how well you will perform. It also affects how much body fat, glycogen or even muscle tissue you burn. Get it wrong and you may find yourself struggling to complete your planned workout and performing under-par. Even worse, you could end up burning muscle rather than fat as your fuel reserves dip. Get your pre-exercise nutrition right and you'll have plenty of energy to train hard and perform at your best. Eating the right amount and type of carbohydrate as well as timing your pre-exercise meal correctly will help avoid common problems such as fatigue, dizziness, fainting and stitch.

? *Why eat before training?*

The main purpose of your pre-workout meal is to stabilise your blood sugar levels during exercise. It also staves off hunger and minimises the risk of problems such as stitch and hypoglycaemia (low blood sugar levels). But don't expect your pre-workout meal to fuel your muscles. There isn't enough time for your body to turn the food into glycogen – the muscles' main fuel supply – so your body must rely on existing glycogen (and fat) stores. It takes 24 hours to refill muscle glycogen stores, so what you've consumed the previous day matters. For most regular exercisers, a daily diet providing carbohydrates of around 280–350 g for a 70 kg person.

? *Should you train on empty?*

It is definitely not advisable to train on an empty stomach, especially if you want to improve strength, endurance or performance. Firstly, you're more likely to feel lethargic and unmotivated

when you haven't eaten for several hours. Eating a light snack a couple of hours before your workout will reduce the temptation to skip your training. Secondly, when your brain isn't getting enough fuel you'll feel faint, lose concentration and risk injury. You may become light-headed, weak and shaky – all symptoms of low blood sugar levels – and this will certainly stop you from working out. Finally, you are more likely to fatigue early as muscle glycogen and blood sugar levels dip. Rather like a car running out of petrol, your body will come to a weary halt. You wouldn't take your car out on a long journey when the petrol tank is low. So you can't expect to exercise very hard or very long when you haven't fuelled your body for several hours.

? *How much to eat before training*

The exact amount you should eat depends on your body weight (heavier people need more) and how hard and long you plan to exercise (eat more for longer, harder workouts). In general, if you plan to workout for less than 2 hours, aim to eat around 1 g carbohydrate per kg of body weight (or 70 g for a 70 kg person) or 400–600 calories. For longer workouts or endurance events eat around 2 g carbohydrate per kg of body weight (or 600–800 calories). Don't eat a big meal just before a workout otherwise you will feel uncomfortable, sluggish and 'heavy'.

? *When to eat before training*

Ideally, you should aim to have a meal 2–4 hours before a workout. This should leave enough time to partially digest your food although, in practice, the exact timing of your pre-workout meal may depend on your daily schedule. You should feel comfortable neither full nor hungry. According to a study at the University of North Carolina, United States, eating a moderately-high Carbohydrate, low fat meal 3 hours before exercise allows you to exercise longer and perform better.

? *What are the best foods to eat just before a workout?*

Slow-burning or low glycaemic index (GI) foods – that is foods that produce a gradual rise in blood sugar levels are the best foods before a workout. Studies at the University of Sydney, Australia, have found that athletes who ate a low-GI meal before exercise were able to keep going considerably longer than those who ate a high-GI meal. It seems that low-GI foods help

spare muscle glycogen and avoid problems of low blood sugar levels during long training sessions. Low-GI meals may also help you burn more fat during exercise. A 2003 study at Loughborough University, UK, found that runners who ate a low-GI meal 3 hours before exercise burned more fat than those who ate a high-GI meal with the same amount of carbs. Remember, a low-GI meal can either be low-GI carbs, such as fruit and yoghurt or higher-GI foods combined with protein and/or fat, such as Weetabix with milk or a baked potato with cheese.

? *Why drink before training?*

It is important to ensure that you are properly hydrated before training to minimise the risk of dehydration during exercise. Even mild dehydration can result in early fatigue as your body is unable to cool itself efficiently, which puts extra stress on the heart and lungs. Exercise feels tougher when you are dehydrated and you cannot train as hard.

? *When to drink before training?*

The best strategy is to keep hydrated throughout the day rather than load up with fluid just before your workout. Try to make a habit of drinking water regularly. Have a glass of water first thing in the morning and then schedule drinks during your day. Aim for at least 8 glasses ($1^{1/2}$–2) daily, and more in hot weather or workout days. It's better to drink little and often rather than drinking large amounts in one go, which promotes urination and a greater loss of fluid. Carry a bottle of water with you everywhere: to the gym, office and in the car, as a constant reminder to drink. It need not be expensive bottled water. A simple water bottle or a bottled-water bottle will do just refill with tap water. Drink before you get thirsty. By the time your thirst mechanism kicks in you may have lost around 2 per cent of your body weight as water. If you relied on your thirst alone, you would replace only 50–75 per cent of the amount you need.

? *How much to drink before training?*

The American College of Sports Medicine Drink recommends drinking 2–4 glasses of water (400–600 ml) during the 2–3 hours before you workout. Don't drink it all in one go – divide into several smaller amounts and sip at regular intervals.

Activity 3.6

Dear Student, discuss briefly on the following questions with your partners.

1. *What are the overall recommendations before exercise/training regarding to the food and drinks we consumed?*
2. *What are the "DO's" and "Don't Do's" of nutrition before exercise?*

3.2.2 Nutrition During Exercise

Everyone exercising for longer than 30 minutes will certainly benefit from drinking something during exercise. But with the growing array of sports drinks, sports 'waters' and energy drinks it's a confusing choice for most regular exercisers. If you plan to exercise longer than 60 minutes, you may also benefit from additional carbohydrate. But should you take carbohydrates in liquid or solid form? Exactly how much and when? The following section provides the answers to help you fuel on the move.

Carbohydrate ingestion during exercise has been shown to improve exercise performance in events lasting 60 min or longer by maintaining high plasma glucose levels and high carbohydrate oxidation rates. From numerous studies, it appears that most of the soluble carbohydrates are oxidized at similar rates (i.e. glucose, maltose, sucrose, glucose polymers and dispersable starch). The exceptions are fructose, galactose and insoluble starch, which are oxidized at slightly slower rates. Interestingly, however, is the finding from one particular study that when 50 g of fructose and 50 g of glucose were ingested together, during exercise, the cumulative amount of carbohydrate oxidized was 21% greater compared with the ingestion of 100 g of glucose.

The amount of carbohydrate ingested is important for its contribution to energy expenditure and sparing of liver glycogen. However, the oxidation of exogenous carbohydrate does not exceed 1.0-1.1 g/min, even when much greater quantities are ingested. This observation suggests that the maximum carbohydrate intake during exercise should not exceed 60 g/h. Nowadays, carbohydrate electrolyte drinks and energy bars, which are promoted to give rapid provision of carbohydrate and fluid, are the most common food supplements in endurance sports. Untrained individuals may benefit as much from the carbohydrate fluid supply as trained athletes.

Optimally, athletes should ingest a carbohydrate electrolyte drink throughout exercise. It has recently been shown that ingestion of carbohydrate throughout exercise improves performance more than when an identical amount of carbohydrate is consumed late in the exercise period. The ideal nutritional strategy during exercise should:

- provide sufficient carbohydrate to maintain blood glucose levels and carbohydrate oxidation
- provide water and electrolytes to prevent fluid imbalance
- not cause any gastro-intestinal discomfort
- taste good.

Optimal carbohydrate sources have been mentioned previously and are also discussed in the section on post-exercise recovery below. The effectiveness of a sports drink in supporting fluid balance depends on a number of factors of which carbohydrate and sodium content, and osmolality are very important. The ideal sports drink for carbohydrate and fluid replacement should have a relatively low carbohydrate content of between 40 and 80 g/l, have an osmolality which is moderately hypotonic to isotonic, and have a sodium content of between 400 and 1200 mg/l. Individual sweat loss can be estimated from weight loss. By regularly monitoring nude body weight before and after training sessions and competitions, it is possible to predict an individual's fluid loss in a certain race under most environmental conditions. Weight loss will be due not only to fluid loss but also to glycogen and fat oxidation; for example, over 90 min of exercise 100-250 g of substrate may be oxidized.

However, since the main limitation to maintaining fluid balance appears to be the volume of beverage that can be tolerated in the gastrointestinal tract, in most situations it is advisable to drink as much as possible. Completely restoring sweat losses by fluid consumption may not always be possible because these losses may exceed 2 l/h, and ingestion of such amounts usually cannot be accepted by the gastrointestinal tract. Therefore, the volume of drink that can be tolerated by the intestine usually limits fluid and carbohydrate consumption. This highlights the importance of making 'drinking during exercise' a part of the regular training programme.

The palatability of a drink is very important because it stimulates consumption and hence increases the intake of fluid and carbohydrate. In addition, the taste and flavor of a drink may also influence the rate of gastric emptying. Flavors and aromas, which are perceived as being unpleasant, may slow gastric emptying and may even cause nausea. The following are general recommendations of nutrition during exercise:

1. During intense exercise lasting >45 min a carbohydrate drink should be ingested. This may improve performance by reducing/delaying fatigue.
2. Consume 60 g of carbohydrate per hour of exercise. This can be optimally combined with fluid in quantities related to needs determined by environmental conditions, individual sweat rates and gastrointestinal tolerance.
3. During exercise of < 45 min duration there appears to be little need to consume carbohydrate.
4. The type of soluble carbohydrate (glucose, sucrose, glucose polymer, etc.) ingested does not appear to make much difference when ingested in low to moderate quantities; fructose and galactose are less effective. However, a combination of fructose and glucose may have physiological benefits. Insoluble carbohydrate sources are relatively slowly absorbed and oxidized, and are therefore not recommended for high intensity events.
5. Athletes should consume beverages containing carbohydrate throughout exercise, rather than water during the early part of an exercise bout followed by carbohydrate beverages at the later stages of the exercise.
6. Avoid drinks which have extremely high carbohydrate contents (>20%) and those with a high osmolality (>500 mosmol/kg) because fluid delivery will be hampered and gastrointestinal problems may occur.
7. Try to predict the fluid loss during endurance events of >90 min. The volume of fluid to be ingested should in principle at least equal the predicted fluid loss. While exercising in warm weather with low humidity, athletes have to drink more to replace sweat loss and the drinks can be diluted. During events in cold weather, athletes require less fluid volume to maintain fluid balance but will still require the carbohydrate to maintain blood glucose levels, therefore the carbohydrate content of the drinks can be more concentrated.

8. Large volumes of a drink stimulate gastric emptying more than small volumes. Therefore, we recommend that athletes ingest a fluid volume of 6-8 ml/kg BW, 3-5 min prior to the start to 'prime' the stomach, followed by smaller amounts (2-3 ml/kg BW) every ~15-20 min.
9. The volume of fluid that athletes can ingest is usually limited. Athletes should practise drinking while exercising as training can increase the volume that the gastrointestinal tract will tolerate.
10. After drinking a large quantity, the stomach may feel empty and uncomfortable. If this occurs it may be wise to eat some easily digested solid food. During long, low intensity competitions solid food can be eaten in the early stages of the event.
11. Fibre and protein content, and high carbohydrate concentration and osmolality have been associated with the development of gastrointestinal symptoms during exercise, and thus should be avoided.

Activity 3.7

Dear Student, discuss briefly on the following questions with your partners.

1. *Describe the ideal nutritional strategy during exercise should?*
2. *What are the "DO's" and "Don't Do's" of nutrition during exercise?*

3.2.3 Nutrition after Exercise

The quicker you can begin refueling after exercise, the quicker your body will recover. Any workout depletes your stores of glycogen – the readily available fuel stored in your muscles – and breaks down muscle tissue. Your aim is to rebuild these fuel stores and repair damaged muscle fibers as soon as possible. It is during this post-exercise period that your body gets stronger and fitter. Wait too long and you'll feel sluggish; get it right and you'll recover faster. Follow the practical steps outlined in this section and you will be well on the road to recovery.

? *How much to drink?*

Start drinking before you even get showered and changed. The sooner you begin replacing the fluid you have lost through sweat, the sooner you will recover and cut the risk of post-workout

dehydration. Fail to drink enough and you will feel listless with a risk of headache and nausea. As a rule of thumb, you need to drink 750 ml of water for every 0.5 kg of body weight lost during your workout. (1 kilogram of lost weight is equal to 1 litre of sweat, which needs to be replaced with 1.5 litres of fluid). Try to drink around 500 ml over the first 30 minutes, little and often, then keep sipping until you are passing clear or pale urine. Drinking slowly rather than guzzling the lot in one go will hydrate you better. If you pass only a small volume of dark yellow urine, or if you feel headachy and nauseous, then you need to keep on drinking.

? *What to drink?*

If you have exercised for less than an hour, plain water is a good choice followed by a carbohydrate-rich snack within 2 hours. For longer or particularly intense workouts, a drink containing carbohydrate (sugar or maltodextrin) and sodium may further speed your recovery. According to research at the University of Iowa, carbohydrate at levels of approximately 6 g carbohydrate per 100 ml increases the speed of water absorption into the bloodstream. Try fruit juice diluted with an equal volume of water, diluted squash (1 part squash: 6 parts water) or an isotonic sports drink containing 3–8g carbohydrate per 100 ml. 'High energy' or 'recovery' drinks contain higher levels of carbohydrate: up to 12 g per 100 ml, mostly in the form of maltodextrin. These drinks may be useful following intense workouts longer than 90 minutes and are popular with ultra-endurance athletes. Avoid refueling after exercise with an alcoholic drink. Rehydrate with water or sports drink before celebrating with lager, beer or shandy (the extra fluid will help attenuate dehydration) or alternate water with an alcoholic drink.

? *When to eat or drink?*

Whether you are hungry or not, the quicker you consume food or drink after a workout, the quicker your body will recover. The enzymes that are responsible for making glycogen are most active immediately after your workout, leaving you a 2-hour window to reload your muscle glycogen. Carbohydrate is converted into glycogen one and a half times faster than normal during this post-exercise period. Wait more than two hours and your body's ability to convert what you eat or drink to glycogen drops by 66 per cent. The longer you wait, the longer it will take to start the recovery process. If you work out daily, speedy recovery is crucial so have a

carbohydrate-rich drink or snack as soon as possible after your workout – ideally within 30 minutes and no later than 2 hours.

Activity 3.8

Dear Student, discuss briefly on the following questions with your partners.

1. *Describe the ideal nutritional strategy during exercise should?*
2. *What are the "DO's" and "Don't Do's" of nutrition during exercise?*

3.2.4 How to Plan your Training Diet

Use the Fitness Food Pyramid to devise your daily menu or to check your current eating plan. The foods in the lower layers of the pyramid should form the main part of your diet while those at the top should be eaten in smaller quantities.

- Include foods from each group in the pyramid each day.
- Make sure you include a variety of foods within each group.
- Aim to include the suggested number of portions from each food group each day.

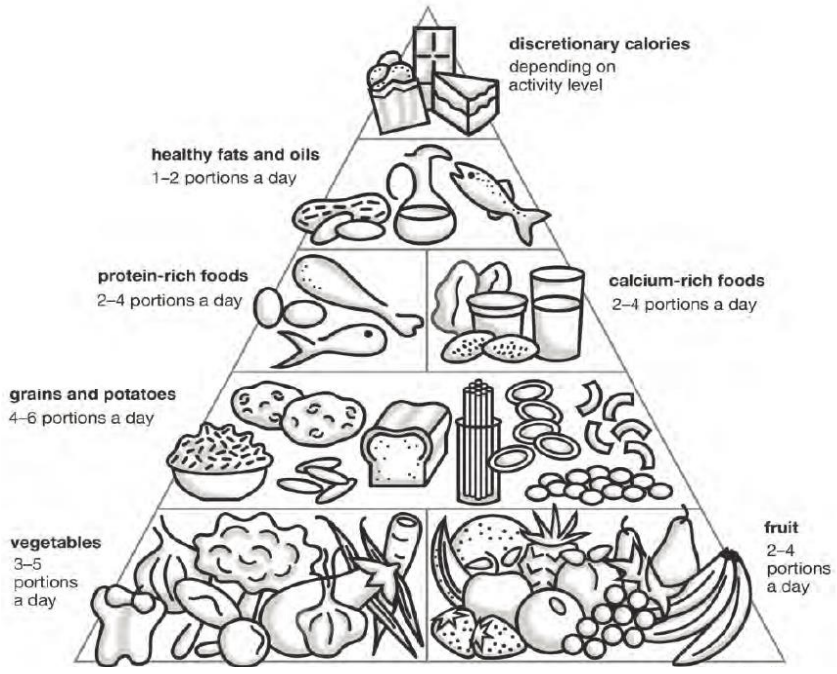

Figure 3.2 Fitness Food Pyramid

UNIT SUMMARY

The interplay between nutrition and physical activity is as frequently misunderstood as the relationship between industrialization and global climate; most people tend to either underemphasize ("as long as I get enough exercise I can eat whatever I want") or overemphasize ("each mouthful of food must conform to rigid requirements") the importance of nutrition to exercise performance. Making sound nutritional choices does not guarantee athletic prowess but consistently making poor choices almost certainly constrains performance. More specifically, sound nutrition is necessary to effectively train and take advantage of training stimuli and living a healthier life in general.

SELF-TEST EXERCISE

1) Which statement is true about simple carbohydrates?
   A) They have little nutritional value
   B) They are rich in protein and minerals
   C) They are higher in dietary fiber
   D) All
2) Which of the following is incorrect about fiber?
   A) It is a non digestible carbohydrate
   B) It can lower blood cholesterol level
   C) It aids in the process of digestion
   D) None
3) Which statement is incorrect about fats?
   A) They provide less energy than carbohydrates
   B) They provide concentrated energy
   C) They are essential for healthy skin
   D) All
4) Which of the following is incorrect about cholesterol?
   A) a high level of cholesterol will be a risk factor for coronary heart disease
   B) It is required for production of sex hormones
   C) It is present only in plant products.
   D) All
5) Among the alternatives given below, which one is true about vitamins?
   A) Excess water soluble vitamins are stored in the body
   B) Excess fat soluble vitamins are stored in the body
   C) They are required in a very small amount
   D) All except 'A'

UNIT FOUR

HEALTH RELATED COMPONENTS OF FITNESS AND PRINCIPLES OF EXERCISE PRESCRIPTION

UNIT OBJECTIVES

By the end of this unit you should be able to:

- Identify the five components of health related physical fitness components
- Analyse health risks associated with excessively low body fatness
- Understand health risks associated with over fatness
- Appreciate and value the benefits of regular physical exercise to healthy living.
- Recognize the means and methods of developing the health related components of physical fitness

✪ INTRODUCTION

Research in exercise science has provided guidelines for the development of a safe and efficient program to improve personal fitness. The purpose of this chapter is to provide you with an overview of the health related components of fitness and principles of exercise prescription for improving your physical fitness. The basic concepts contained within this chapter can be applied to men and women as well as individuals of all ages and fitness levels.

4.1. Health Related Components of Fitness

The overall goal of a total health related physical fitness program is to optimize the quality of

life. The specific goals of this type of fitness program are to reduce the risk of disease, to improve total physical fitness so that, daily tasks can be completed with less effort and fatigue. Also some conditioning programs aimed at improving sport performance, may reduce the risk disease this is not their primary purpose. The single goal of sport conditioning is to improve physical performance in a specific sport. However, the weekend athlete who engages in a total health related physical fitness program could also improve his or her physical performance in many sports. Specifically, a health related fitness program improves sport performance by increasing muscular strength and endurance, improving flexibility and reducing the risk of injury.

Exercise scientists do not always agree on the basic components of physical fitness. However, most do agree that the five major components of total health-related physical fitness are: cardiorespiratory endurance, muscular strength, muscular endurance, flexibility and body composition

4.1.1. Cardiorespiratory Fitness

Meaning and Concepts of Cardiorespiratory Fitness

Cardiorespiratory fitness: (sometimes called aerobic fitness or cardiorespiratory endurance) is considered to be a key component of health-related physical fitness. It is a measure of a heart's ability to pump oxygen-rich blood to the working muscles during exercise. It is also a measure of the muscle's ability to take up and use the delivered oxygen to produce the energy needed to continue exercising. In practical terms, cardiorespiratory endurance is the ability to perform endurance-type exercise such as (distance running, cycling, swimming, etc.). The individuals that have achieved a high measure of cardiorespiratory endurance are generally capable of performing 30 to 60 minutes of vigorous exercise without undo fatigue.

4.1.2. Muscle Fitness

Meaning and Concepts of Muscle Fitness

There are two components of muscle fitness: strength and muscular endurance.

Muscular strength: Is the maximal ability of a muscle to generate force. It is evaluated by how much force a muscle can generate during a single maximal contraction. Practically, this means how much weight that an individual can lift during one maximal effort.

Muscular strength is important in almost all sports. Sports such as football, basketball, and events in track and field require a high level of muscular strength. Even non-athletes require some degree of muscular strength to function everyday life. For example, routine tasks around the home, such as lifting bags of groceries and moving furniture, require muscular strength. Weight training results in an increase in the size and strength of muscles.

Muscular Endurance: Muscular endurance is defined as the ability of a muscle to generate force over and over again. Although muscular strength and muscular endurance are related they are not the same. These two terms can be best distinguished by examples. An excellent example of muscular strength is a person lifting a heavy barbell during one maximal muscular effort. In contrast, muscular endurance is illustrated by a weightlifter performing multiple lifts or repetition of a lightweight.

Most successfully played sports require muscular endurance. For instance, tennis players who must repeatedly swing their racquets during a match require it. Many every day activities also require some level of it.

Muscle Structure and Contraction

Muscle Structure: Skeletal muscle is a collection of long thin cells called **fibers**. These fibers has surrounded by a dense layer of connective tissue called **fascia** that holds the individual fibers together and separates muscle from surrounding tissues. Muscles are attached to bone by connective tissues known as tendons. Muscular contraction causes the tendons to pull on the bones, thereby causing movement.

Muscle Contraction: Muscle contraction is regulated by signals coming from motor nerves. Motor nerves originate in the spinal cord and send nerve fibers to individual muscles throughout the body. The motor nerve and individual muscle fiber make contact at the neuromuscular junction (where the nerve and muscle fiber meet). Note that each motor nerve branches and then

connects with numerous individual muscle fibers. The motor nerve and all of the muscle fibers it controls is called a motor unit.

A muscle contraction begins when a message to contract (called a nerve impulse) reaches the neuromuscular junction. The arrival of the nerve impulse triggers the contraction process by permitting the interaction of the two key contractile proteins in muscle (actin and myosin). These contractile proteins, also called filaments, are pulled over each other by small arms or cross-bridges connecting them. The movement of the myosin filament over the actin filament has been called "sliding" and results in muscular shortening and the generation of force. Because of this sliding action, the theory of how muscles contract has been termed the sliding filament theory. Recall that muscular contraction requires energy; this energy is supplied by the breakdown of ATP.

Because the nerve impulse initiates the contractile process, it is logical that the removal of the nerve signal from the muscle would "turn off" the contractile process. Indeed, when a motor nerve ceases to send signals to a muscle, contraction stops. Occasionally, however, an uncontrolled muscular contraction occurs, resulting in a muscle cramp.

Types of Muscle Contractions

Muscle contractions are classified into two major categories: isotonic and isometric. Isotonic (also called dynamic) contractions: are those that result in movement of a body part. Most exercise or sports skills utilize isotonic contractions. For example, lifting a dumbbell involves movement of a body part and is therefore classified as an isotonic contraction.

An isometric (also called static) contraction: requires the development of muscular tension but results in no movement of body parts. A classic example of an isometric contraction is, the individual exerting force against an iron bar mounted on the wall of a building; the muscle is developing tension but the wall is not moving and therefore neither is the body part. Isometric contractions occur commonly in the postural muscles of the body during sitting or standing; for instance, they are responsible for holding the head upright.

Note that isotonic contractions can be further subdivided into concentric, eccentric, and isokinetic contractions.

Concentric contractions are isotonic muscle contractions that result in muscle shortening. The upward movement of the arm is an example of a concentric contraction. In contrast, eccentric contractions (Also called negative contractions) are defined as contractions in which the muscle exerts force while it lengthens. **An eccentric contraction** occurs when, for example, an individual resists the pull of a weight during the lowering phase of weight lifting. Here, the muscle is developing tension, but the force developed is not great enough to prevent the weight from being lowered.

Isokinetic Muscle Contractions are concentric or eccentric contractions performed at a constant speed. That is, the speed of muscle shortening or lengthening is regulated at a fixed, controlled rate. A weight-lifting machine that controls the rate of muscle shortening generally accomplishes this.

Muscle Fiber Types

There are three types of skeletal muscle fibers: Slow twitch, fast twitch, and intermediate. These fiber types differ in their speeds of contraction and in fatigue resistance. Most human muscles contain a mixture of all three fibers types. Before beginning a strength-training program, it is helpful to have an understanding of each.

Slow-Twitch Fibers: As the name implies slow-twitch fibers contract slowly and produce small amounts of force; however, these fibers are highly resistant to fatigue. Slow-twitch fibers, which are red in appearance, have the capacity to produce large quantities of ATP aerobically, making them ideally suited for a low-intensity prolonged exercise like walking or slow jogging. Further, because of their resistance to fatigue, most postural muscles are composed primarily of slow-twitch fibers.

Fast-Twitch Fibers: Fast-twitch fibers contract rapidly and generate great amounts of force but fatigue quickly. These fibers are white and have a low aerobic capacity, but they are well

equipped to produce ATP anaerobically. With their ability to shorten rapidly and produce large amounts of force, fast-twitch fibers are used during activities requiring rapid or forceful movement, such as jumping, sprinting, and weight lifting.

Intermediate Fibers: Are although more red in color, possess a combination of the characteristics of fast- and slow-twitch fibers. They contract rapidly, produce great force, and are fatigue resistant due to a well-developed aerobic capacity. Intermediate fibers contract more quickly and produce more force than slow-twitch fibers but contract more slowly and produce less force than fast-twitch fibers. They are more fatigue resistant than fast-twitch fibers but less fatigue resistant than slow-twitch fibers.

4.1.3. Flexibility

Meaning of Flexibility

The body is flexible. It is supposed to be flexible. You must be able to bend and reach that something you dropped on the floor. You must be able to zip the back of your favorite dress on your own. You must be able to reach that book you need to read at the top shelf. These are simple activities. Nothing grand about them, you merely stretched out a bit. However, if there are difficulties in doing such simple motions, then you have to stretch your limits. You already need a stretching program.

Flexibility is the ability to move joints freely through their full range of motion. Flexible individuals can bend and twist at their joints with ease. Without routine stretching muscles and tendons shorten and become tight, this can retard the range of motion around joints and impairer flexibility. Individual needs for flexibility vary. Certain athletes require great flexibility in order to accomplish complex movements. The average individual requires less flexibility than the athlete however; everyone needs some flexibility in order to perform activities of daily living. Research suggests that flexibility is useful in preventing some types of muscle-tendon injuries and may be useful in reducing low back pain.

Stretching Techniques

Though there are a number of stretching techniques, three kinds of stretching techniques are commonly used to increase flexibility: ballistic, static, and proprioceptive neuromuscular facilitation. However, because ballistic stretching promotes the stretch reflex and increases the risk of injury to muscles and tendons, only the static and proprioceptive neuromuscular facilitation methods are recommended. A brief discussion of each of these stretching techniques follows.

Static Stretching

Static stretching is extremely effective for improving flexibility and has gained popularity over the last decade. Static stretching slowly lengthens a muscle to a point at which further movement is limited (slight discomfort is felt) and requires holding this position for a fixed period of time. The optimal amount of time to hold the stretch for maximal improvement in flexibility is unknown. However, most investigators agree that holding the stretch position for 20 to 30 seconds (repeated three to four times) results in an improvement in flexibility. Compared with ballistic stretching, the risk of injury associated with static stretching is minimal. Another benefit of static stretching is that, when performed during the cool-down period, it may reduce the muscle stiffness associated with some exercise routines

Proprioceptive Neuromuscular Facilitation

It is a relatively new technique for improving flexibility. Proprioceptive neuromuscular facilitation (PNF) combines stretching with alternating contracting and relaxing of muscles. There are two common types of PNF stretching: contract-relax (C-R) stretching and contract-relax/antagonist contract (CRAC) stretching. The CR stretch technique calls for first contracting the muscle to be stretched. Then, after relaxing the muscle, the muscle is slowly stretched. The CRAC method calls for the same contract-relax routine but adds to this the contraction of the antagonist muscle, the muscle on the opposite side of the joint. The purpose of contracting the antagonist muscle is to promote a reflex relaxation of the muscle to be stretched.

Activity 4.1.

How do PNF techniques compared with ballistic and static stretching?

First, PNF has been shown to be safer and more effective in promoting flexibility than ballistic stretching. Further, studies have shown PNF programs to be equal to, or in some cases superior to, static stretching for improving flexibility. However, one disadvantage of PNF stretching is that some stretches require a partner.

4.1.4. Body composition

Meaning of Body Composition

The term body composition refers to the relative amounts of fat and lean body tissue (muscle, organs, bone) found in your body.

Activity 4.2

Think a while about the rationale for including body composition as a component of health related physical fitness

The rationale for including body composition as a component of health related physical fitness is that having a high percentage of body fat (a condition known as obesity) is associated with an increased risk of development of type 2 diabetes and contributes to joint stress during movement. In general being over fat elevates the risk of medical problems. Lack of physical activity has been shown to play a major role in gaining body fat. Conversely, regular exercise is an important factor in promoting the loss of body.

Health Risks Associated With Over Fatness

Obesity has been elevated from a secondary to a primary risk factor for heart disease. Prior to 1998, obesity was considered to be a secondary risk factor for heart disease. The reason for this was that the effects of obesity were thought to be mediated by other risk factors, such as high blood pressure and blood lipids. Because of the mounting evidence of the relationship of obesity to health risk, especially risk for heart disease, the American heart Association classifies obesity as a primary risk factor, along with high blood lipids, high blood pressure, tobacco use, and sedentary living.

Physical fitness provides protection from the health risk of obesity. Recent research suggests that people who are above normal standards for BMI are not especially at risk if they participate in regular physical activity and possess relatively high levels of cardiovascular fitness. In fact active people who have a high BMI are at less risk than inactive people with normal BMI levels. Even high levels of body fatness may not be especially likely to increase disease risk in a person has a good metabolic fitness as indicated by healthy blood fat levels, normal blood pressure, and normal blood sugar levels. It is when several of these factors are present at the same time that risk levels increase dramatically. For this reason, it is important to consider your cardiovascular and metabolic fitness levels before drawing conclusions about the effects of high body weight or high body fat levels on health and wellness. This information also points out the importance of periodically assessing your cardiovascular and metabolic fitness levels.

Over fatness and obesity can contribute to degenerative disease, health problems, and even shortened life. Some disease and health problems are associated with over fatness and obesity. In addition to the higher incidence of certain disease and health problems, evidence shows that people who are moderately over fat have a 40 percent higher than normal risk of shortening their life span. More sever obesity results in a 70 percent higher than normal death rate. This is evidenced by the very high life insurance premiums paid by obese individuals.

> ***Overweight:*** *weight in excess of normal; not harmful unless it is accompanied by over fatness*

Heart disease is not the only disease that is associated with obesity. Diabetes is another leading killer that is associated with all components of metabolic fitness, including obesity. The incidence of diagnosis this disease has increased six fold in the past 40 years. Recent studies also indicate a significant increase in risk for breast cancer among the obese. High blood pressure asthma, and back pain are other conditions associated with obesity.

Statistics indicates that underweight people also have a higher than normal risk for premature death. Though adequate evidence shows extreme leanness (e.g., anorexia nervosa) can be life threatening, many underweight people included in these studies have lost weight because of a

medical condition such as cancer. It appears that the medical problems are often the reason for low body weight rather than low body weight being the source of the medical problems. Most experts agree that people who are free from disease and who have lower than average risk for premature death.

Excessive abdominal fat and excessive fatness of the upper body can increase the risk of various diseases. The location of body fat can influence the health risk associated with obesity. A variety of terms are associated with the location of body fat. Fat in the upper part of the body is sometimes referred to as **"Northern hemisphere"** fat and a body type high in this type of fat is sometimes called the **"apple" shape** (see figure 4.1). Upper body fat is also referred to as android fat because it is more characteristic of men than women. Postmenopausal women typically have a higher amount of upper body fat than premenopausal women. Lower body fat, such as in the lower hip and upper legs, is sometimes referred to as "southern hemisphere" fat. This body type is sometimes called the "pear" shape. Lower body fat is also referred to as gynoid fat because it is more characteristic of women than men.

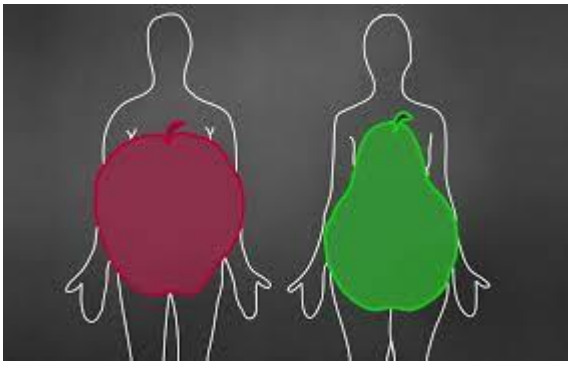

Figure 4.1 Body shape illustration

Body fat that is located in the core of the body is referred to as central fat or visceral fat. Visceral fat is located in the abdominal cavity (see figure 4.1) as opposed to subcutaneous fat, which is located just under the skin. Though subcutaneous fat (skinfold measure) can be used to estimate body fatness, it is not a good indicator of central fat. A useful indicator of fat distribution is the waist-to-hip circumference ratio. A high waist circumference relative to hip circumference yields a high ratio that is indicative of high visceral fat. Visceral fat is associated with high blood fat levels as well as other metabolic problems. It is also associated with incidence of heart attack,

stroke, chest pain, breast cancer, and early death. The ratio provides an indicator of both upper body fatness and visceral fat.

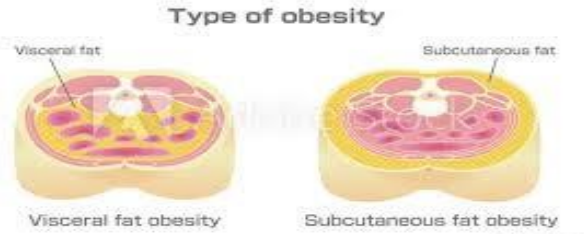

Figure 4.2 Illustration of the location of body fat

As you grow older, central and upper body fat levels tend to increase. Recent evidence indicates that people who exercise regularly accumulate less visceral fat and less upper body fat as they grow older. This suggests that regular physical activity throughout life will result in smaller waist-to-hip ratios and reduced risk for various chronic diseases.

Health Risks Associated With Excessively Low Body Fatness

Excessive desire to be thin or low in body weight can result in health problems. In western society, the near obsession with thinness has been, at least in part, responsible for eating disorders. Eating disorders, or altered eating habits, involve extreme restriction of food intake and/or regurgitation of foot to avoid digestion. The most common disorders are anorexia nervosa, bulimia, and anorexia athletica. All of these disorders are most common among highly achievement-oriented girls and young women, although they affect virtually all segments of the population.

Anorexia nervosa is the most sever eating disorder. If untreated, it is life threatening. Anorexics restrict food intake so severely that their bodies become emaciated. Among the many characteristics of anorexia nervosa are fear of maturity and inaccurate body image. The anorexic starves him/ herself and may exercise compulsively or use laxatives to prevent the digestion of food in an attempt to attain excessive leanness. The anorexic's self-image is one of being too fat, even when the person is too lean for good health. Assessing body fatness using procedures such as skinfolds and observation of the eating habits may help identify people with anorexia. Among anorexic girls and women, development of an adult figure is often feared. People with this

disorder must obtain medical and psychological help immediately, as the consequences are severe. About 25 percent of those with anorexia do compulsive exercise in an attempt to stay lean.

Bulimia is a common eating disorder characterized by bingeing and purging. Disordered eating patterns become habitual for many people with bulimia. They alternate between bingeing and purging. Bingeing means the periodic eating of large amounts of food at one time. A binge might occur after a relatively long period of dieting and often consists of junk foods containing empty calories. After a binge, the bulimic purges the body of the food by forced regurgitation or the use of laxatives. Another form of bulimia is bingeing on one day and starving on the next. The consequences of bulimia are not as severe as anorexia, but they can result in serious mental, gastrointestinal, and dental problems. Bulimic may or may not be anorexic. It may not be possible to use measures of body fatness to identify bulimia, as the bulimic may be lean, normal, or excessively fat.

? *Is there an ideal body fat percentage?*

The ideal weight and fat-lean ratio varies considerably for men and women by age. The average healthy adult body fat range regardless of age is 15 to 20 percent for men and 20 to 25 percent for women. A woman with more than 32 percent body fat and males with more than 25 percent body fat are considered to be at increased risk for disease.

Trained athletes tend to be at the low end of this scale due to their increased lean weight (muscle mass) compared to untrained individuals. While low levels of body fat seem to be related to improved performance, body composition alone is not a great predictor of sports success. There is little evidence of any health benefit when men drop under 8 percent and women drop under 14 percent body fat.

? *How low is too low?*

While the average body fat percent in the United States is increasing, extremely low body fat percent is also a health problem. A certain amount of body fat is vital for the body to be healthy

and function normally.

? ***What health effects result from having an extremely low body fat percentage?***

The attempt to reduce body fat by extreme measures not only leads to decreased exercise performance, but it also can lead to severe health complications. Nutrient deficiencies and fluid/electrolyte imbalance from low food intake can lead to increased risk of fractures, illness, loss of reproductive function and serious conditions such as dehydration, and starvation. The medical complications of a very low body fat involve almost every body function and include the cardiovascular, endocrine, reproductive, skeletal, gastrointestinal, renal, and central nervous systems with the possibility to develop conditions such as heart damage, gastrointestinal problems, shrinkage of internal organs, immune system abnormalities, disorders of the reproductive system, loss of muscle tissue, damage to the nervous system, abnormal growths, and even death.

? ***How do people manage their body fat?***

The three most important factors to maintain a healthy body fat percentage are:

1. Maintaining your lean muscle mass through routine strength training (minimum 2x/week for each muscle group)
2. Maintaining a healthy well-balanced diet that is low in fat (<30% of calories from fat)
3. Maintaining consistent sleep patterns (minimum 7 hours/night). Always seek the assistance of a medical or health and fitness professional for personal program guidance in reducing or managing your body fat.

4.2. Principles of Exercise Prescription for Health and Fitness

Doctors often prescribe medications to treat certain diseases, and for every individual there is an appropriate dosage of medicine to cure an illness. Similarly, for each individual, there is a correct dosage of exercise to effectively promote physical fitness, called an exercise prescription. Exercise prescriptions should be tailored to meet the needs of the individual. It should include fitness goals, mode of exercise, a warm-up, a primary conditioning period, and a cool-down. The

following sections provide a general introduction to each of these components.

4.2.1. Fitness Goals

Establishing short-term and long-term fitness goals is an important part of an exercise prescription. Goals serve as motivation to start an exercise program. Further, attaining your fitness goals improves self-esteem and provides the incentive needed to make a lifetime commitment to regular exercise.

A logical and common type of fitness goal is a performance goal. You can establish performance goals in each component of health-related physical fitness. Table 4.2 illustrates a hypothetical example of how Mr X might establish short-term and long-term performance goals using fitness testing to determine when she has reached her objective. The column labeled "current status" contains individual's fitness ratings based on tests performed prior to starting his/her exercise program. After consultation with his/her instructor, the individual has established short-term goals that he/she hopes to achieve within the first 8 weeks of training. Note that the short-term goals are not "fixed in stone" and can be modified if the need arises. Susie's long-term goals are fitness levels that she hopes to reach within the first 18 months of training. Similar to short-term goals, long-term goals can be modified to meet changing needs or circumstances.

In addition to performance goals, consider establishing exercise adherence goals. That is, set a goal to exercise a specific number of days per week. Exercise adherence goals are important because fitness will improve only if you exercise regularly! In writing your personal fitness goals, consider the following guidelines:

Set Realistic Goals

The most important rule in setting goals is that, you must establish realistic ones. After a thorough self-evaluation and consultation with your instructor, set fitness goals that you can reach. Because failure to reach goals is discouraging, establishment of realistic short-term goals is critical to the success of your exercise program.

Establish Short-Term Goals First

Reaching short-term fitness goals is a great motivation to continue exercising. Therefore, establishment of realistic short-term goals is critical. After reaching a short-term goal, establish a new one.

Table 4.1 Fitness improvement goals

Fitness category	Current status	Short term goal	Long term goal
Cardiorespiratory fitness	Poor	Average	Excellent
Muscular strength	Poor	Average	Excellent
Muscular endurance	Very poor	Average	Good
Flexibility	Poor	Average	Good
Body composition	High fat	Moderately high	Optimal

Set Realistic Long-Term Goals

In establishing long-term goals consider your physical limitations. Heredity plays an important role in determining our fitness limits. Therefore, in establishing long-term goals, set goals that are realistic for you and not based on performance scores of other people.

Establish Lifetime Maintenance Goals

In addition to short-term and long-term goals, consider establishing a fitness maintenance goal. A maintenance goal is established when your fitness goals have been met and your focus becomes remaining physically active and fit.

List Goals in Written Form

A key to meeting goals is to write them down and put them in a place where you can see them every day. Goals can be forgotten if they are not verifiable in writing. Further, remember that all goals should be periodically reevaluated and modified if necessary. Just because goals are in writing does not mean that they cannot be changed.

Recognize Obstacles to Achieving Goals

If you do not make your fitness goals a serious priority; you will keep putting them off until they

no longer exist. Once you begin your fitness program, be prepared to make mistakes (e.g., skip workouts and lose motivation) and backslide some (e.g., fitness level declines). This is normal. However, once you realize that you have stopped making progress toward your goals, you must get back on track and start making progress again as soon as you can.

The importance of fitness goals cannot be overemphasized. Goals provide structure and motivation for a personal fitness program.

4.2.2. Mode of Exercise

Every exercise prescription includes at least one mode of exercise that is, a specific type of exercise to be performed. For example, to improve cardio respiratory fitness, you could select from a wide variety of exercise modes, such as running, swimming, or cycling. Key factors to consider when selecting an exercise mode are enjoyment, availability of the activity, and risk of injury.

Physical activities can be classified as being either high impact or low impact based on the amount of stress placed on joints during the activity. Activities that place a large amount of pressure on joints are called high-impact activities, whereas low-impact activities are less stressful" Because of the strong correlation between high-impact modes of exercise and injuries, many fitness experts recommend low-impact activities for fitness beginners or for those individuals susceptible to injury (such as participants who are older or overweight). Examples of high-impact activities include running, basketball, and high-impact aerobic dance. Low-impact activities include walking, cycling, swimming, and low-impact aerobic dance.

4.2.3. Warm-Up

A warm-up is a brief (5- to 15-minute) period of exercise that precedes the workout. It generally involves light calisthenics or a low-intensity form of the actual mode of exercise and often includes stretching exercises as well. The purpose of a warm-up is to elevate muscle temperature and increase blood flow to those muscles that will be engaged in the workout. A warm-up can also reduce the strain on the heart imposed by rapidly engaging in heavy exercise and may reduce the risk of muscle and tendon injuries.

4.2.4. Primary Conditioning Period: The Workout Plan

The major components of the exercise prescription that make up the primary conditioning period are the mode of exercise (described earlier), frequency, intensity, and duration. The frequency of exercise is the number of times per week that you intend to exercise. In general, the recommended frequency of exercise to improve most components of health-related physical fitness is three to five times per week.

The intensity of exercise is the amount of physiological stress or overload placed on the body during the exercise. The method for determining the intensity of exercise varies with the type of exercise performed. For example, because heart rate increases linearly with energy expenditure (effort) during exercise, measurement of heart rate has become a standard means of determining exercise intensity during training to improve cardio respiratory fitness. Although heart rate can also be used to gauge exercise intensity during strength training, the number of exercise repetitions that can be performed before muscular fatigue occurs is more useful for monitoring stress during weight lifting. For instance, a load that can be lifted only five to eight times before complete muscular fatigue is an example of high-intensity weight lifting. In contrast, a load that can be lifted 50 to 60 times without resulting in muscular fatigue is an illustration of low-intensity weight training.

Finally, stretching muscles beyond their normal lengths improve flexibility. Intensity of stretching is monitored by the degree of tension or discomfort felt during the stretch. Low-intensity stretching results in only minor tension (or limited discomfort) on the muscles and tendons. In contrast, high-intensity stretching places great tension or moderate discomfort on the muscle groups being stretched.

Another key component of the exercise prescription is the duration of exercise, the amount of time invested in performing the primary workout. Note that the duration of exercise does not include the warm-up or cool-down. In general, research has shown that 20 to 30 minutes per exercise session (performed at least three times per week) is the minimum amount of time

required to significantly improve physical fitness.

4.2.5. Cool-Down

The cool-down (sometimes called a warm-down) is a 5- to 15-minute period of low-intensity exercise that immediately follows the primary conditioning period. For instance, a period of slow walking might be used as a cool-down following a running workout. A cool-down period accomplishes several goals (see Figure 5.6). First, one primary purpose of a cool-down is to allow blood to be returned from the muscles back toward the heart. During exercise, large amounts of blood are pumped to the working muscles. On cessation of exercise, blood tends to remain in large blood vessels (called pooling) located around the exercised muscles. Failure to redistribute pooled blood after exercise could result in your feeling lightheaded or even fainting. Prevention of blood pooling is best accomplished by low-intensity exercise using those muscles utilized during the workout, Finally, some fitness experts argue that post-exercise muscle soreness may be reduced as a result of a cool-down. Although a cool-down period may not eliminate muscular soreness entirely, it seems possible that the severity of exercise-induced muscle soreness may be reduced in people who perform a proper cool-down.

4.3. Individualizing the Workout

A key point to remember about exercise prescriptions is that the prescription should be tailored to the needs and objectives of the individual. Although the same general principles of exercise training apply to everyone, no two people are the same. Therefore, the exercise prescription should consider such factors as the **individual's general health, age, fitness status, musculoskeletal condition,** and **body composition**.

? ***How Much Exercise Is Enough?***

An often-asked question is, ***"How much exercise is enough?"*** The answer depends on your specific exercise goals. There are two separate thresholds of exercise training. The minimum level of physical activity required to achieve some of the health benefits of exercise is called ***the***

threshold for health benefits and the maximal level is called ***threshold for improvement of performance.***

Recent studies have demonstrated that some health benefits can be achieved by very low levels of physical activity (gardening, slow walking**,** and so on). When these activities are performed regularly and for a considerable duration (expending at least 2000 calories per week) For example, 9 to 12 hours of gardening may be required to expend 2000 calories.

Note, however, that although low physical activity may improve health, it does not generally improve the components of health-related physical fitness; that is, physical fitness is not improved. The minimum dose of exercise required to improve health-related physical fitness is called the threshold of training. Each component of physical fitness has its own threshold for improvement.

4.4. Means and Methods of Developing Cardiorespiratory Fitness

4.4.1. Exercise Prescription for Cardio Respiratory Fitness

After assessing your health status and evaluating your current cardio respiratory fitness level (see unit 5), you are ready to develop your exercise prescription to improve your cardio respiratory fitness. As we have discussed, the exercise training session is composed of three primary elements: warm-up, workout (primary conditioning period), and cool-down.

Warm-Up

Every workout should begin with a warm-up. The major purposes of a warm-up are to increase heart rate and body temperature and to elevate blood flow to the muscles. A warm-up usually consists of 5 to 15 minutes of slow-paced exercise. This allows a gradual warming of the muscles and connective tissue before engaging in vigorous exercise. Although some fitness instructors recommend stretching during the warm-up period, we suggest that stretching exercises are optional during the warm-up and probably should be emphasized following the cool-down period. The rationale is that stretching is probably most effective after the muscles are warmed from the workout.

A warm-up routine for someone who will be jogging for (the cardio respiratory workout might consist of the following steps:

1. 1 to 3 minutes of light calisthenics
2. 1 to 3 minutes of walking at a pace that elevates heart rate by 20 to 30 beats/min above rest.
3. 2 to 4 minutes of stretching (optional)
4. 2 to 5 minutes of jogging at a slow pace to gradually elevate the heart rate toward the desired target heart rate (discussed later in the section on intensity). If the workout is to consist of exercise modes other than jogging, substituting other exercise modes, as in steps 2 and 4, could follow the same general warm-up routine. For instance, if cycling were the primary mode of exercise, low-intensity cycling exercise would take the place of walking and jogging in steps 2 and 4.

Workout: Primary Conditioning Period

This component of an exercise prescription to improve cardiovascular fitness includes the mode, frequency, intensity, and duration of exercise. Let's discuss each of these factors briefly.

Mode: several modes of exercise can be used to improve cardio respiratory fitness. Some of the most common are walking, jogging, cycling, and swimming. In general, any activity that uses a large muscle mass (e.g., the legs) in a slow, rhythmical pattern can be used to improve cardio respiratory fitness.

There are several key factors to consider when choosing an exercise mode. First, the activity must be fun! Choose an exercise mode that you enjoy. Your chances of sticking with an exercise program are much greater if you choose an activity that you like. A second consideration is that the type of exercise you choose must be convenient and accessible. For example, don't choose swimming if the nearest pool is 50 miles from your home. Similarly, don't choose cycling if you don't have use of a bicycle. A final factor is the risk of injury. High-impact activities such as running present a greater risk of injury than low-impact activities such as cycling and swimming. A common sense rule when choosing an exercise mode is that if you tend to be injury-prone, choose a low-impact activity. In contrast, if you rarely experience exercise-related injuries, feel

free to choose either a high- or low-impact activity mode.

Historically, most exercise prescriptions for improving cardio respiratory fitness have used only one activity mode. However, there is a current Popular Activities That Promote Cardio respiratory Fitness. Aerobic dance, Bicycling, Calisthenics (heavy), Cross-country skiing, Rope skipping, Rowing, Running, Skating (ice or roller), Stair climber, Swimming and Walking. Tend toward using cross training (i.e., a variety of activity modes) for training the cardio respiratory system. Many fitness experts feel that participating in only one mode of exercise is boring and leads to more exercise dropouts. Further, cross training may also reduce the frequency of injury.

Frequency: Although cardio respiratory fitness gains can he achieved with as few as two exercise sessions per week, the general recommendation for exercise frequency is three to five sessions per week to achieve near-optimal gains in cardio-respiratory fitness and minimal risk of injury. If training is injury-free, the frequency can be increased to 5 days per week if desired. It is, however, unlikely that even greater health or fitness benefits will accrue from exercising more than 5 days per week.

Intensity: Improvements in cardio respiratory fitness occur when the training intensity is approximately 50% of VO2 max (this work rate is often called the training threshold). Although improvements in cardio respiratory fitness can be achieved by exercising at VO2 max, most people could only exercise for 1 to 2 minutes at that intensity. Thus, the recommended range of exercise intensity for improving health-related physical fitness is between 50% and 85% VO2 max.

Recall that training intensity can be monitored indirectly by measurement of heart rate. The heart rate, which corresponds to exercise intensity sufficient to improve health-, related physical fitness is called the target heart rate (THR). The most popular method of determining THR is the percentage of maximal heart rate (HR max) method. This method works on the principles that exercise intensity (i.e., % VO2 max) can be estimated by measurement of exercise heart rate. To compute our THR using this method, simply multiply your HR max by both 90% and 70% to arrive at the high and low ends of your THR range.

For example, the maximal HR of a 20-year-old college student can be estimated by the following formula.

HR max = 220 - 20 = 200 beats/min

The **THR** is then computed as 200 beats/min x 0.70 = 140 beats/min 200 beats/min x 0.90 =180 beats/min

THR = 140 to 180 beats/min

In this example, the THR to be maintained during a workout to improve cardiorespiratory fitness is between 140 and 180 beats/min; this range of exercise intensities is sometimes called the **training sensitive zone**.

The reasoning behind using 70% and 90% of your maximal heart rate to compute your target rate is based on the relationship between percent HR max and percent VO2 max (see Table 6.1). Note that 70% of HR max represents the heart rate

Table 4.2. The Relationship between Target Heart Rate, Percent HR Max, and the Percent of VO2 Max for an Individual 20 Years of Age

THR beats/minute	% Vo2 max	% HR max (beats/minute)
186	90	93
180	85	90
173	80	87
166	75	83
160	70	80
153	65	76
146	60	73
140	55	70
134	49	67

Associated with an exercise intensity of approximately 50% VO2 max (the lower end of the training sensitive zone), and that 90% of HR max represents approximately 85% VO2 max (the upper end of the recommended training sensitive zone). Finally, it is important to remember that your THR will change, as you get older due to the decrease in maximal heart rate. For instance, while the THR for a 20-year-old college student is between 140 and 180 beats/min, the THR for

a 60-year-old is 108 - 139 beats/min.

Activity 4.3.

Calculate the high and low ends of your THR range based on the above formula.

Duration: Recall that, duration of exercise does not include the warm-up or cool-down. In "general, exercise durations that have been shown to be most effective in improving cardio respiratory fitness are between 20 and 60 minutes. The reason for this large "window" of duration is that the time required to obtain training benefits depends on both the individual's initial level of fitness and the training intensity. For example, a poorly conditioned individual may only require 20 to 30 minutes of daily exercise at his or her THR to improve cardio respiratory fitness. In contrast, a highly trained person may require daily exercise sessions of 40 to 60 minutes' duration to improve cardio respiratory fitness.

Another key point to understand is that improvement of cardio respiratory fitness by engaging in low-intensity exercise requires a longer daily training duration than high-intensity exercise. For example, an individual training at 50% of VO2 max may require daily exercise duration of 40 to 50 minutes to improve cardio respiratory fitness. In contrast, the same person exercising at 70% of VO2 max may require only 20 to 30 minutes of daily exercise to achieve the same effect.

Safety: Improving Cardio respiratory Fitness without Injury

What is the optimal combination of exercise intensity, duration, and frequency to promote cardio respiratory fitness while minimizing risk of injury? The optimal exercise intensity to improve cardio respiratory fitness without increasing the risk of injury is between 60% and 80% of VO2 max (73-87% HR max). Further, note that the optimal frequency and duration are 3 to 4 days/ week and 20 to 60 minutes/day, respectively.

Cool-Down

Every training session should conclude with a cool-down (5-15 minutes of light exercises and stretching). A primary purpose of a cool-down is to promote blood return to the heart, thereby preventing blood from pooling in the arms and legs, which could result in dizziness and/or

fainting. A cool-down may also decrease the muscle soreness and cardiac irregularities that sometimes appear after a vigorous workout. Although cardiac irregularities are rare in healthy individuals, it is prudent to cool down and reduce the risk.

A general cool-down of at least 5 minutes (of light exercise such as walking and calisthenics) should be followed by 5 to 30 minutes of flexibility exercises. In general, stretching exercises should focus on the muscles used during training. The type and duration of the stretching session depends on your flexibility goals.

4.4.2. Starting and Maintaining a Cardio respiratory Fitness Program

Two key elements in any fitness program are the specific short-term and long-term goals. Without these, motivation to continue training is hard to maintain. Many fitness experts agree that the lack of goals is a major contributor to the high dropout rates seen in many organized fitness programs. It pays to establish both short-term and long-term fitness goals before you start your training program.

If your training plans include running, walking, aerobic dance, or other weight-bearing activities, it is important to exercise in good shoes. Unfortunately, good running, walking, or aerobics shoes are not cheap. However, investing in good shoes is important for both comfort and injury prevention. Look for a well-cushioned shoe with the following features:

Soft comfortable upper material; adequate toe room (as indicated by comfort); well-padded heel and ankle collar; firm arch support; and a heel lift (a wedge that raises the heel about 1/2 inches higher than the sole). Many athletic shoe stores have well-trained sales personnel to assist you in the selection process.

Developing an Individualized Exercise Prescription

Regardless of your initial fitness level or your choice of exercise mode, the exercise prescription to improve cardiovascular fitness usually has three stages: the starter phase, the slow progression phase, and the maintenance phase. Let's see how each of these training phases can be tailored to individual needs.

1. **Starter Phase:** the quickest way to extinguish enthusiasm for an exercise program is to try to accomplish too much too soon. Many people begin an exercise program with great excitement and anticipation of improved fitness levels and weight loss. Unfortunately, this early excitement can lead to exercising too hard during the first training session! This can promote sore muscles and undue fatigue. Therefore, start your fitness program slowly.

The objective of the starter phase is to gradually permit the body to adapt to exercise and to avoid soreness, injury, and personal discouragement. It usually lasts 2 to 6 weeks, depending on your initial fitness level. For example, if you are in a poor cardio respiratory fitness category, you may spend 6 weeks in the starter phase. In contrast, if you have a relatively high initial cardio respiratory fitness level, you may spend only 2 weeks in the starter phase.

The starter program should include a warm-up, a low-intensity training phase, and then a cool-down. In general, the intensity of exercise during the starter phase should be relatively low (up to 70% of HR max). The following are key points to remember during the starter phase of an exercise program:

- Start at an exercise intensity that is comfortable for you.
- Don't increase your training duration or intensity if you are not comfortable.
- Be aware of new aches or pains. Pain is a symptom of injury and indicates that rest is required to allow the body to repair itself.

2. **Slow Progression Phase:** the slow progression phase may last 12 to 20 weeks, with exercise progression being more rapid than during the starter phase. The intensity can be gradually elevated. And the frequency and duration of exercise increased, depending on fitness goals and the presence or absence of injuries. In general, this stage should reach an exercise frequency of 3 to 4 times/week and exercise duration of at least 30 minutes per session. Exercise intensity should range between 70% and 90% HR max, depending on your personal fitness goals.
3. **Maintenance Phase:** the average college-age student will generally reach the maintenance phase of the exercise prescription after 16 to 28 weeks of training. At this stage you should have achieved your fitness goal and are no longer interested in increasing your training load.

The objective now becomes to maintain this level of fitness. As the old saying goes, "Fitness is not something you can put in the bank." To maintain cardio respiratory fitness, you must continue to train on a regular basis. The key question now is how much training is required during the maintenance phase to prevent a decline in cardio respiratory fitness?

Several studies have shown that the primary factor in maintaining cardio respiratory fitness is the intensity of exercise. If the exercise intensity and duration remain the same as during the final weeks of the slow progression phase, frequency can be reduced to as few as 2 days per week without a significant loss in fitness. In addition, if frequency and intensity remain the same as during the final weeks of the slow progression phase, duration can be reduced to as few as 20 to 25 minutes per day. In contrast, when frequency and duration are held constant, a one-third decreases in intensity results in a significant decrease in cardio respiratory fitness. To summarize, if exercise intensity is maintained, the exercise frequency and duration necessary to maintain a given level of cardio respiratory fitness are substantially less than that required to improve fitness levels.

4.4.3. Training Techniques

Endurance training is a generic term that refers to any mode of exercise aimed at improving cardio respiratory fitness. Over the years, numerous endurance-training techniques have evolved. In the next section, we discuss several common ones.

1. Cross Training

As previously mentioned, cross training is a popular form of training that uses several different training modes. It may mean running on one day, swimming on another day, and cycling on another day. One advantage of this type of training is that cross training reduces the boredom of performing the same kind of exercise day after day. Further, it may reduce the incidence of injuries by avoiding overuse of the same body parts. The disadvantage of cross training is the lack of training specificity. For example, daily jogging does not improve swimming endurance because the arm muscles are not trained during jogging. Similarly, swimming does not improve jogging endurance. In general, to improve endurance in a particular activity, training should

utilize exercises similar to that activity.

2. Long, Slow Distance Training

Long, slow distance training, or continuous training, requires a steady, sub maximal exercise intensity (i.e., the intensity is generally around 70% HR max). It is one of the most popular cardio respiratory training techniques and can be applied to any mode of exercise. During the progression phase of the exercise program, an individual may find this type of training enjoyable because the exercise intensity does not increase. If injuries are not a problem, there is no reason why the duration of the training cannot be extended to 40 to 60 minutes/session. An advantage of continuous training is that risk of injury is lower than in more intensive training.

3. Interval Training

Interval training means undertaking repeated bouts or intervals of relatively intense exercise. The duration of the intervals can be varied, but a 1- to 5-minute duration is common. Each interval is followed by a rest period, which should be equal to, or slightly greater than, the interval duration. For example, if you are running 400-meter intervals on a track, and it takes you approximately 90 seconds to complete each run, your rest period between efforts should be at least 90 seconds. Interval training is a common training technique among athletes who have first established a base of endurance training and wish to attain much higher fitness levels in order to be more competitive in a particular sport. With correct spacing of exercise and rest periods, more work can be accomplished with interval training than with long, slow distance training. A major advantage of interval training is the variety of workouts it allows, which may reduce the tedium associated with other forms of training.

4. Fartlek Training

Fartlek is a Swedish word meaning, "speed play," and it refers to a popular form of training for long-distance runners. Fartlek training is much like interval training, but it is not as rigid in its work-to-rest interval ratios. It consists of free form running done out on trails, roads, golf courses, and the like. An advantage of fartlek training is that these workouts provide variety and reduce the possibility of boredom.

Motivation to Maintain Cardio respiratory Fitness

Every year, millions of people make the decision to start an exercise routine. Unfortunately, over half those who begin a cardio respiratory fitness pro gram quit within the first 6 months. Although there are many reasons for this high dropout rate, a lack of time is commonly cited as a major one. Although finding time for exercise in a busy schedule is difficult, it is not impossible. The key is to schedule a regular time for exercise and stick with it. A small investment in time to exercise can reap large improvements in fitness and health. Think about the time required to improve cardio respiratory fitness in the following way. There are 168 hours in every week. All you need is three, 30-minute workouts per week to improve cardio respiratory fitness. Including the associated warm-ups, cool-downs, and showers, this is about 3 hours per week, which is less than 2% of the total week. This leaves you with 165 hours per week to accomplish all of the other things that you need to do. The bottom line is, with proper time management, anyone can find time to exercise.

In order for you to keep the commitment to develop cardio respiratory fitness, exercise must be fun. Therefore, choose a training technique that you enjoy. Further, your chosen exercise mode should be convenient. Failure to meet both of these criteria increases your risk of becoming an exercise dropout.

One of the things that make exercise enjoyable is the interaction with friends. Therefore, exercising with a partner is an excellent idea because it makes physical activity more fun and helps maintain your sense of commitment to a regular exercise routine. In choosing an exercise partner, choose someone that you enjoy interacting with and someone who is a good exercise role model.

Keeping a record of your training program is helpful in several ways. It assists you in keeping track, of your training progress and serves as a motivating factor when you begin to notice improvements in your fitness level.

Finally, it is normal to experience some discomfort and soreness associated with your first several exercise sessions. Don't let this discourage you. In a short time, the soreness will fade and the discomfort associated with exercise will begin to disappear. As your fitness level improves, you will start to feel better and look better. Although reaching and maintaining a reasonable level of cardio respiratory fitness will always require time and effort, the rewards will be well worth the labor.

4.5. Means and Methods of Developing Muscle Fitness

4.5.1. Guiding Principles for Designing a Strength and Endurance Program

In unit 1 we discussed the general principles of the development of training programs to improve physical fitness. Before we discuss the specifics of how to develop a strength-training program, let's discuss several principles that should be considered in developing a muscular strength and endurance-training program.

The Concept of Progressive Resistance Exercise

(PRE) is an application of the overload principle applied to strength and endurance exercise programs. Even though the two terms can be used interchangeably, PRE is preferred when discussing weight training. Progressive resistance exercise means that as strength and endurance are increased, the load against which the muscle works must be periodically elevated for strength and endurance gains to be realized.

Principle of Specificity

The principle of specificity of training means that development of muscular strength and endurance is specific to the muscle group that is exercised and the training intensity. First, the muscles that are trained will be the only muscles improving in strength and endurance. For example, if an individual has low-back pain and wishes to improve the strength of the supporting musculature of the lower back, it would be of no benefit to strengthen the arm muscles. The specific muscles involved with movement of the lower back should be the ones trained. Second, the training intensity determines whether the muscular adaptation is primarily an increase in

strength or endurance. High-intensity training (i.e., lifting heavy weights four to six times) results in an increase in both muscular strength and size with only limited improvements in muscular endurance. Conversely, high-repetition, low-intensity training (i.e., lifting light weights 15 times or more) promotes an increase in muscular endurance, with only limited improvements in muscular size and strength.

Designing a Training Program for Increasing Muscle Strength -

There are numerous approaches to the design of weight-training programs. Any program that adheres to the basic principles described earlier will result in an improvement in strength and endurance. However, the type of weight training program that you develop for yourself depends on your goals and the types of equipment available to you. Next, we discuss several other considerations in the development of a weight-training program.

Safety Concerns

Before we discuss the specifics of how to develop a weight-training program, the need for safety should be emphasized. Although weight training can be performed safely, some important guidelines should be followed:

- When using free weights (like barbells), have spotters (helpers) assist you in the performance of exercises. They can help you if you are unable to complete a lift. Many weight machines reduce the need for spotters.
- Be sure that the collars on the end of the bars of free weights are tightly secured to prevent the weights from falling off. Dropping weight plates on toes and feet can result in serious injuries. Again, many weight machines reduce the potential risk of dropping weights.
- Warm up properly before doing any weight-lifting exercise.
- Do not hold your breath during weight lifting. A recommended breathing pattern to prevent breath holding during weight lifting is to exhale while lifting the weight and inhale while lowering. Also, breathe through both your nose and mouth.
- Although debate continues as to whether high-speed weight lifting is superior to slow-speed lifting in terms of strength gains, slow movements may reduce the risk of injury. Therefore, because slow movement during weight lifting certainly results in an increase in both muscle

size and strength, it would be wise to take this approach.

- Use lightweights in the beginning so that the proper maneuver can be followed with each exercise. This is particularly true when lifting free weights.

Training to Improve Strength versus Training to Improve Endurance

Weight training programs specifically designed to improve strength and programs designed to improve muscular endurance differ mainly in the number of repetitions (i.e., the number of lifts performed) and the amount of resistance. That a weight training program using low repetitions and high resistance results in the greatest strength gains, whereas a weight training program using high repetitions and low resistance results in the greatest improvement in muscular endurance. However, it is important to appreciate that while low-repetition/high-resistance training appears to be the optimal training method to increase strength, this type of training improves muscular endurance as well. In contrast, although, weight training using high repetition/low resistance improves endurance, this training method results in only small strength increases, particularly in less fit individuals.

Activity 4.4.

Think about the basic differences between training for muscular strength and muscular endurance.

4.5.2. Types of Weight Training Programs

Weight training programs can be divided into three general categories classified by the type of muscle contraction involved: isotonic, isometric, and isokinetic.

Isotonic Programs: Isotonic programs, like isotonic contractions, utilize the concept of contracting a muscle against a movable load (usually a free weight or weights mounted by cables or chains to form a weight machine). Isotonic programs are very popular and are the most common type of weight training program in use today.

Isometric Programs: An isometric strength training program is based on the concept of contracting a muscle at a fixed angle against an immovable object, using an isometric or static contraction. Interest in strength training increased dramatically during the 1950s with the finding that maximal strength could be increased by contracting a muscle for 6 seconds at two-thirds of maximal tension once per day for 5 days per week! Although subsequent studies suggested that these claims were exaggerated, it is generally agreed that isometric training can increase muscular strength and endurance.

Two important aspects of isometric training make it different from isotonic training. First, in isometric training, the development of strength and endurance is specific to the joint angle at which the muscle group is trained. Therefore, if isometric techniques are used, isometric contractions at several different joint angles are needed to gain strength and endurance throughout a full range of motion. In contrast, because isotonic contractions generally involve the full range of joint motion, strength is developed over the full movement pattern. Second, the static nature of isometric muscle contractions can lead to breath holding (called a valsalva maneuver), which can reduce blood flow to the brain and cause dizziness and fainting. In an individual at high risk for coronary disease, the maneuver could be extremely dangerous and should always be avoided. Remember: Continue to breathe during any type of isometric or isotonic contraction!

Isokinetic Programs: Again, isokinetic contractions are isotonic contractions performed at a constant speed. Isokinetic training is a relatively new strength training method, so limited research exists to describe its strength benefits compared with those of isometric and isotonic programs. Isokinetic exercises require the use of machines that govern the speed of movement during muscle contraction (isokinetic refers to constant speed of movement). The first isokinetic machines available were very expensive and were used primarily in clinical settings for injury rehabilitation. Recently, less expensive machines have become available that utilize a piston device much like a shock absorber on a car to limit the speed of movement throughout the range of the exercise.

4.5.3. Exercise Prescription for Weight Training: An Overview

You have been already introduced the general concepts of the intensity, duration, and frequency

of exercise required to improve physical fitness. Although these same concepts apply to improving muscular strength and endurance via weight training, the terminology used to monitor the intensity and duration of weight training is unique. For example, the intensity of weight training is measured not by heart rate but by the number of repetition maximums." Similarly, the duration of weight training is monitored not by time but by the number of sets performed; let's discuss these two concepts briefly.

The intensity of exercise in both isotonic and isokinetic weight training programs is measured by the concept of the repetition maximum BML the RM is the maximum load that a muscle group can lift a specified number of times before tiring. For example, 6 RM is the maximal load that can be lifted six times. Therefore, the amount of weight lifted is greater when performing a low number of RMs than a high number of RMs; that is, the weight lifted while performing 4 RMs is greater than the weight lifted while performing 15 RMs.

The number of repetitions (reps) performed consecutively without resting is called a set. In the example of 6 RM, 1 set = 6 reps. Because the amount of rest required between sets will vary among individuals depending on how fit they are, the duration of weight training is measured by the number of sets performed, not by time.

Although disagreement exists as to the optimum number of reps and sets required to improve strength and endurance, some general guidelines can be provided. To improve strength, 3 sets of 6 reps for each exercise are generally recommended. The concept of progressive resistance applied to a strength training program involves increasing the amount of weight to be lifted a specific number of reps. For example, suppose that 3 sets of 6 RMs were selected as your exercise prescription for increasing strength. As the training progresses and you become stronger, the amount of weight lifted must be increased. A good rule of thumb is that once 8 reps can be performed, the load should be increased to a level at which 6 reps are again maximal. Note that in each strength-training program, 6 reps result in the greatest strength improvement. A key point in those programs involving 3 sets result in the greatest strength gains. This is because the third set requires the greatest effort and thus is the greatest overload for the muscle. To improve muscular endurance, 4 to 6 sets of 18 to 20 reps for each exercise are recommended,

Note that endurance could be improved by either increasing the number of reps progressively while maintaining the same load, or increasing the amount of weight while maintaining the same number of reps. The advantage of the latter program is that it would also improve muscular strength.

Activity 4.5

What role does frequency play in the development of strength? How many days per week will be optimal?

Most research suggests that 2 to 3 days of exercise per week is optimal for strength gains. However, once the desired level of strength has been gained, studies have shown that one high-intensity training session per week is sufficient to maintain the new level of strength. Finally, although limited research exists regarding the optimal frequency of training to improve muscular endurance, 3 to 5 days per week seem adequate.

4.5.4. Developing an Individualized Exercise Prescription

The exercise prescription for strength training has three stages: the starter phase, the slow progression phase, and the maintenance phase.

1. **Starter Phase:** the primary objective of the starter phase is to build strength gradually with-out developing undue muscular soreness or injury. This can be accomplished by starting your weight training program slowly beginning with light weights, a high number of repetitions, and only 2 sets per exercise. The recommended frequency of training during this phase is twice per week. The duration of this phase varies from 1 to 3 weeks, depending on your initial strength fitness level. A sedentary person might spend 3 weeks in the starter phase, whereas a relatively well-trained person may only spend 1 to 2 weeks.
2. **Slow Progression Phase:** This phase may last 4 to 21 weeks depending on your initial strength level and your long-term strength goal. The transition from the starter phase to the slow progression phase involves three changes in the exercise prescription: increasing the frequency of training from 2 to 3 days per week; an increase in the amount of weight lifted and a decrease, in the number of repetitions; and an increase in the number of sets performed from 2to 3 sets. The objective of the slow progression phase is to gradually increase muscular

strength until you reach your desired level. After reaching your strength goal, your long-term objective becomes to maintain this level of strength-lie entering the maintenance phase of the strength training exercise prescription.

3. **Maintenance Phase:** After reaching your, Strength goals, the problem now become, how you do maintain this strength level? The bad news is that maintaining strength will require a lifelong weight training effort. Strength is lost if you do not continue to exercise. The good news is that the effort required maintaining muscular strength is less than the initial effort needed to gain strength. Research has shown that as little as one workout per week is required to maintain strength.

4.6. Means and Methods of Developing Flexibility

4.6.1. Exercise Prescription for Improving Flexibility

For safety reasons, all flexibility programs should consist of either PNF or static stretching exercises. The frequency and duration of a stretching exercise prescription should be 2 to 5 days per week for 10 to 30 minutes each day. The first week of a stretching regimen is considered the starter phase. The first week should consist of one stretching session, with one session added per week during the first 4 weeks of the slow progression phase of the program. Initially, the duration of each training session should be approximately 5 minutes, increasing gradually to approximately 20 to 30 minutes following 6 to 12 weeks of stretching during the slow progression phase. The physiological rationale for increasing the duration of stretching is that each stretch position is held for progressively longer durations as the program continues. For example, begin by holding each stretched position for 15 seconds, and then add 5 seconds each week up to 30 seconds. Start by performing each of the exercises once (1 rep) and progress to 4 reps.

? *What about the intensity of stretching?*

In general, a limb should not be stretched beyond a position of mild discomfort. Simply increasing the range of motion during the stretch alters the intensity of stretching. That is, your range of motion will gradually increase as your flexibility improves during the training program.

These exercises were designed to use in a regular program of stretching to increase flexibility. Exercises are presented which use the major joints and muscle groups of the body in which range of motion tends to decrease with age and disuse. The exercises include both static and PNF movements and may require a partner.

4.6.2. How to Avoid Hazardous Exercises

There are many exercises that are potentially harmful to the musculoskeletal system. Exercises actually causes an injury depends on how they are performed. Use the following key points during an exercise session to help prevent injury.

- ✓ Avoid breathe holding. Try to breathe as normally as possible during the exercise.
- ✓ Avoid full flexion of the knee or neck
- ✓ Avoid full extension of the knee, neck, or back.
- ✓ Do not stretch muscles that are already stretched such as the abdominal muscles
- ✓ Do not stretch any joint to the point that ligaments and joint capsules are stressed
- ✓ Use extreme precaution when using an assistant to help with passive stretches
- ✓ Avoid extension and flexion of the spine in a forceful manner
- ✓ Don’t stretch to the point of pain. Remember you want to stretch muscles, not joints!
- ✓ Don’t use ballistic stretches if you have osteoporosis or arthritis.
- ✓ Don’t ballistically stretch weak or recently injured muscles.
- ✓ Don’t stretch swollen joints without professional supervision

UNIT SUMMARY

Though scientists do not agree on the basic components of physical fitness, most do agree that there are five major components of total health related physical finesses. These are: cardiorespiratory fitness, muscle fitness, flexibility, and body composition.

Fitness programs aimed at the development of the above fitness components is targeted towards optimizing the quality of life. Recently, obesity is becoming from a secondary to a primary risk factor for heart disease and other health problems.

Physical exercise and the development of optimal fitness provide protection from the health risk of Obesity. Research suggested that, individuals who exercise regularly are at low risk of being obese than sedentary individuals. Obesity serves as a get for many health risks such as diabetes, heart attack, chest pain, breast cancer and early death.

It is not only being obese associated with health problems. Excessive desire to be thin or low in body weight even can result in health problems such as increased risk of fracture, illness, loss of reproductive function, dehydration, heart damage, gastrointestinal problem, shrinkage of internal organ, immune system abnormalities, damage to nervous system, abnormal growth and even death.

For individuals in order to develop optimal physical fitness, they must perform the exercise with the correct dosage considering the principles of exercise prescription. Exercise prescription should be specific to the needs of individuals and it should include fitness goal, mode of exercise, a warm up, a primary conditioning period and cool down.

SELF-TEST EXERCISE

1. Discuss the difference between the two components of muscle fitness (muscular endurance and muscular strength)
2. List and define the five components of health related physical fitness
3. Analyse health risks associated with excessively low body fatness and over fatness
4. How regular physical exercise program is important to healthy living
5. What exercise types help to maintain a good cardiorespiratory fitness?

UNIT FIVE

ASSESSMENT OF FITNESS COMPONENTS

UNIT OBJECTIVES

By the end of this unit you should be able to:

- Understand the importance of fitness assessment prior to physical exercise program
- Identify the different means to develop own physical fitness
- Develop skill to assess one's own physical fitness
- Interpret the results of fitness evaluation

✪ INTRODUCTION

An objective evaluation of your current fitness status is important prior to beginning an exercise-training program. This evaluation provides valuable information concerning your fitness strengths and weaknesses and enables you to set reasonable fitness goals. Further, testing your initial fitness level also provides a benchmark against which you can compare future evaluations.

Periodic re-testing (e.g., every 3 to 6 months) provides motivating feedback as your fitness program progresses. This unit presents a battery of physical fitness tests that can assess your fitness level. These tests are designed to evaluate each of the major components of health-related physical fitness. Such as: cardio respiratory fitness, muscular strength, muscular endurance, flexibility, and body composition.

5.1. Evaluating Health Status

? *Is a medical exam required before beginning a fitness program?*

The answer is probably "no", for healthy college-age individuals. Although regular medical exams are encouraged for everyone, most people under 29 years of age generally do not require special medical clearance before beginning a low-to-moderate intensity exercise program. However, if you have any concerns about your health, an examination by a physician is prudent prior to starting an exercise program.

? *Should individuals over 30 years old have a medical exam at the beginning of an exercise program?*

The most conservative answer is "yes." This is particularly true for obese and/or sedentary individuals. The following general guidelines apply:

5.2. Assessment of Cardiorespiratory Fitness

Cardio respiratory fitness is the ability to perform endurance-type exercises (e.g., running, cycling, swimming, etc.) and is considered to be a key component of health-related physical fitness.

The most accurate means of measuring cardio respiratory fitness is the laboratory assessment of maximal oxygen consumption called VO2 max. In simple terms, VO2 max is a measure of the endurance capacity of both the cardio respiratory system and exercising skeletal muscles. Because direct measurement of VO2 max requires expensive laboratory equipment and is very time consuming, it is impractical for general use. Fortunately, researchers have developed numerous methods for estimating VO2 max using simple field tests. In the following paragraphs, we describe several types of field exercise tests designed to evaluate cardio respiratory fitness.

5.2.1. The 1.5-Mile Run Test

One of the simplest and most accurate means of evaluating cardio respiratory fitness is the 1.5-mile run test. This test was popularized by Dr. Kenneth Cooper and works on the physiological

principle that people with a high level of cardio respiratory fitness can run 1.5 miles in less time than less fit individuals. The 1.5-mile run test is excellent for physically active college-age individuals. Due To its intensity however, the 1.5-mile run test is not well suited for sedentary people over 30 years of age, severely deconditioned people, individuals with joint problems, and obese individuals.

The objective of the test is to complete a 1.5-mile distance (preferably on a track) in the shortest possible time. The test is best conducted in moderate weather conditions (avoiding very hot or very cold days). For a reasonably physically fit individual, running or jogging can cover the 1.5-mile distance. For less fit individuals, the test becomes a run/walk test. A good strategy is to try to keep a steady pace during the entire distance. In this regard, it may be beneficial to perform a practice test, in order to determine the optimal pace that you can maintain. Accurate timing of the test is essential, and use of a stopwatch is, best. Interpreting your test results is simple. Table 5.1 contains norms for cardio respiratory fitness using the 1.5-mile run test. Find your sex, age group, and finish time on the table and then locate your fitness category on the left side of the table.

Activity 5.1.

Temesgen is 21 years old and completes the 1.5-mile run in 13 minutes and 25 seconds. Using the Table below locate Johnny's age group and time column.

Table 5.1 Fitness Categories for Cooper's 1.5-Mile Run Test to Determine Cardio respiratory Fitness

Fitness category	**Age category**					
	13-19	**20-29**	**30-39**	**40-49**	**50-59**	**60+**
			Men			
V. poor	>15:30	>16:00	>16:30	>17:30	>19:00	>20:00
Poor	12:11-15:30	14:01-16:00	14:46-16:30	15:36-17:30	17:01-19:00	19:01-20:00
Average	10:49-12:10	12:01-14:00	12:31-14:45	13:01-13:35	14:31-17:00	16:16-19:00
Good	9:41-10:48	10:46-12:00	11:01-12:30	11:31-13:00	12:31-14:30	14:00-16:18
Excellent	8:37-9:40	9:45-10:45	10:01-11:00	10:30-11:30	11:00-12:30	11:15-13:59
Superior	<8:37	<9:45	<10:00	<10:30	<11:00	<11:15

Women						
V. Poor	>18:30	>19:00	>19:30	>20:00	>20:30	>21:00
Poor	16:55-18:30	18:31-19:00	19:01-19:30	19:31-20:30	20:01-20:30	20:31-21:31
Average	14:31-16:54	15:55-18:30	16:31-19:00	17:31-19:30	19:01-20:00	19:31-20:30
Good	12:30-14:30	13:31-15:54	14:31-16:30	15:56-17:30	16:31-19:00	17:31-19:30
Excellent	11:50-12:29	12:30-13:30	13:00-14:00	13:45-15:55	14:30-16:30	16:30-17:30
Superior	<11:50	<12:30	<13:00	<13:45	<14:30	<16:30

5.2.2. The 1-Mile Walk Test

Another field test to determine Cardio respiratory fitness is the 1-mile walk test, which is particularly useful for sedentary individuals. It is a weight-bearing test, however, so individuals with joint problems should not participate. The 1-mile walk test works on the same principle as the 1.5-mile run test. That is, individuals with high levels of Cardio respiratory fitness will complete a 1-mile walk in a shorter time than those who are less conditioned. This test is also best conducted in moderate weather conditions, preferably on a track. Subjects should try to maintain a steady pace over the distance. Again, because test scores are based on time, accurate timing is essential.

The table 5.2 contains norms for scoring cardio respiratory fitness using the 1-mile walk test. Find your age group and finish time on the table and then locate your fitness category on the left side of it.

Table 5.2 Fitness Classifications for 1-Mile Walk Test

Fitness category	**Age category**			
	13-19	**20-29**	**30-39**	**40+**
	Men			
Very Poor	>17:30	>18:00	>19:00	> 21:30
Poor	16:01-17:30	16:31-18:00	17:31-19:00	18:31-21:36"
Average	14:01-16:00	14:31-16:30	15:31-17:30	16:01-18:30
Good	12:30-14:00	14:31-16:30	16:31-17:30	14:00-16:00
Excellent	<12:30	<13:00	<13:30	<14:00

		Women		
V. poor	>18:01	>18:31	>19:31	>20:01
Poor	16:31-18:00	17:01-18:30	18:01-19:30	19:31-20:00
Average	14:31-16:30	15:01-17:00	16:01-18:00	18:00-19:00
Good	13:31-14:30	13:31-15:00	14:01-16:00	14:31-17:59
Excellent	<13:00	<13:30	<14:00	<14:30

5.2.3. The Cycle Ergo meter Fitness Test

For those with access to a cycle ergo meter (a stationary exercise bicycle that provides pedaling resistance via friction applied to the wheel), a cycle ergo meter fitness test is an excellent means of evaluating Cardio respiratory fitness. It offers advantages over running or walking tests for individuals with joint problems due to the non-weight-bearing nature of cycling. Further, because this type of test can be performed indoors, it has advantages over outdoor fitness tests during very cold or hot weather.

5.2.4 The Step Test

An alternative test to determine your cardio respiratory fitness level is the step test. The step test works on the principle that individuals with a high level of cardio respiratory fitness will have a lower heart rate during recovery from 3 minutes of standardized exercise (bench stepping) than less conditioned individuals. Although the step test is not considered the best field method to estimate Cardio respiratory fitness, it does have advantages in that it can be performed indoors and can be used by people at all fitness levels. Further, the step test does not require expensive equipment and can be performed in a short amount of time.

Step height for both men and women should be approximately 18 inches. In general, locker room benches or sturdy chairs can be used as stepping devices. The test is conducted as follows:

1. Select a partner to assist you in the step test. Your partner is responsible for timing the test and assisting you in maintaining the proper stepping cadence (rhythm pace). The exercise cadence is 30 complete steps (up and down) per minute during a 3-minute exercise period, which can be maintained by a metronome or voice cues from your friend ("up, up, down,

down"). Thus you need to make one complete step cycle every 2 seconds (i.e., set the metronome at 60 tones/min and step up and down with each sound). Note that it is important that you straighten your knees during the "up" phase of the test.

2. After completing the test, sit quietly in a chair or on the step bench. Find your pulse and count your heart rate for 30-second periods during the following recovery 'times:

   - ✓ 1.5 minutes post exercise
   - ✓ 2- 2.5 minutes post exercise
   - ✓ 3- 3.5 minutes post exercise

Your partner should assist you in timing the recovery period and recording your recovery heart rates. Note that the accuracy of this test depends on the faithful execution of 30 steps per minute during the test and the valid measurement of heart rate during the appropriate recovery times.

To determine your fitness category, add the three 30-second heart rates obtained during recovery; this is called the recovery index. The table 5.3 contains norms for step test results in a college-age population (18-25 years).

Activity 5.2.

Indicate where a male student with a recovery index of 165 beats would be classified.

Table 5.3 Norms for cardio respiratory fitness using the Sum of three recovery heart rates obtained following the Step Test

Fitness Category	**3-Minute step test recovery index**	
	Women	**Men**
Superior	95-120	95-117
Excellent	121-135	118-132
Good	136-153	133-147
Average	154-174	148-165
Poor	175-204	166-192
V. poor	205-233	193-217

5.3 Assessment of Muscle Fitness

5.3.1 Assessing Muscular Strength

As discussed in unit 4, muscular strength is defined as the maximum amount of force you can produce during one contraction. Muscular strength not only is important for success in athletics, but also is useful for the average person in performing routine tasks at work or home. Strength can be measured by the one-repetition maximum (1 RM) test, which measures the maximum amount of weight that can be lifted one time.

The 1 RM Test

Although the 1 RM test for muscular strength is widely accepted, it has been criticized as unsuitable for use with older individuals or highly deconditioned people. The major concern is the risk of injury. The 1 RM test should therefore be attempted only after several weeks of strength training, which will result in improvements in both skill and strength and reduce the risk of injury during the test. An older or sedentary individual would probably require 6 weeks of exercise training prior to the 1 RM test whereas a physically active college-age student could probably perform the 1 RM test after 1 to 2 weeks of training. The 1 RM test is designed to test muscular strength in selected muscle groups and is performed in the following manner.

- Begin with a 5- to 10-minute warm-up using the muscles to be tested.
- For each muscle group, select an initial weight that you can lift without undue stress.
- Gradually add weight until you reach the maximum weight that you can lift one time.
- If you can lift the weight more than once, add additional weight until you reach a level of resistance such that you can perform only one repetition. Remember that a true 1 RM is the maximum amount of weight that you can lift one time.
- Four common lifts used to measure strength are three of these: (bench press, biceps curl, and shoulder press) for upper body muscle groups. The fourth lift (leg press) measures leg strength.

Table 5.4 contains strength score norms for college-age men and women in each of these lifts.

Your muscle strength score is your percentage of body weight lifted in each exercise. To compute your strength score in each lift, divide your 1 RM weight in pounds by your body weight in pounds and then multiply by 100, For example, suppose a 150-pound man has a bench press 1 RM of 180 pounds. This individual's muscle strength score for the bench press is computed as:

$$\textbf{Muscle strength score} = \frac{\textbf{1RM weight}}{\textbf{Body weight}} \times 100$$

$$\textbf{Therefore, muscle strength score} = \frac{\textbf{180 pounds}}{\textbf{150 pounds}} \times 100$$

$$= 120$$

Using the table below, a muscle strength score of 120 on the bench press places a college age man in the "good" category.

Table 5.4 Fitness category of muscle strength score

Exercise	V. Poor	Poor	Average	Good	Excellent	Superior
			Men			
Bench press	<50	50-99	100-110	111-130	131-149	>149
Biceps curl	<30	30-40	41-54	55-60	61-79	>79
Shoulder press	<40	41-50	51-67	68-80	81-110	>110
Leg press	<160	161-199	200-209	210-229	230-239	>239
			Women			
Bench press	<40	41-69	70-74	75-80	81-99	>99
Biceps curl	<15	15-34	35-39	40-45	56-59	>59
Shoulder press	<20	20-46	47-54	55-59	60-79	>79
Leg press	<100	100-130	131-144	145-174	175-189	>189

5.3.2 Assessing Muscular Endurance

Muscular endurance is the ability of a muscle or muscle group to generate force over and over

again. Although an individual might have sufficient strength to lift a heavy box from the ground to the back of a truck, he or she might not have sufficient muscular endurance to perform this task multiple times. Because many everyday tasks require sub maximal but repeated muscular contractions. Muscular endurance is an important facet of health-related physical Fitness.

Although numerous methods exist to evaluate muscular strength, two simple tests to assess muscular endurance involve the performance of push-ups and sit-ups (also called curl-ups). Push-ups are a measure of muscular endurance using shoulder, arm, and chest muscles, whereas sit-ups primarily evaluate abdominal muscle endurance.

A. The Push-Up Test

The standard push-up test to evaluate muscular endurance is performed in the following way:

- Start by positioning yourself on the ground in push-up position. Your hands should be approximately shoulder width and your legs extended in a straight line with your weight placed on your toes.
- Lower your body, until your chest is within 1 to 2 inches of the ground and raise yourself back to the up position. It is important to keep your back straight and lower your entire body to the ground as a unit.

The push-up test is performed as follows:

✓ Select a partner to count your push-ups and assist in the timing of the test (test duration is 60 seconds). Warm up with a few push-ups. Give yourself a 2- to 3-minute recovery period after the warm-up and prepare to start the test.

✓ On the command "go," start performing push-ups. Your partner counts your pushups aloud and informs you of the amount of time remaining in the test period (e.g., at 15-second intervals). Remember only those push-ups that are performed correctly will be counted toward your total; therefore, use the proper form and make every push-up count.

✓ After completion of the push-up test, use table 5.5 to determine your fitness classification, and record your scores.

Table 5.5 Fitness category based on push-ups (1 min)

Men	Age: 20-29	Age: 30-39	Age: 40-49	Age: 50-59	Age: 60+
Excellent	**54 or more**	**44 or more**	**39 or more**	**34 or more**	**29 or more**
Good	45-54	35-44	30-39	25-34	20-29
Average	35-44	24-34	20-29	15-24	10-19
Poor	20-34	15-24	12-19	8-14	5-9
Very poor	20 or fewer	15 or fewer	12 or fewer	8 or fewer	5 or fewer
Women	**Age 20-29**	**Age 30-39**	**Age 40-49**	**Age 50-59**	**Age:60+**
Excellent	48 or more	39 or more	34 or more	29 or more	19 or more
Good	34-48	25-39	20-34	15-29	5-19
Average	17-33	12-24	8-19	6-14	3-4
Poor	6-16	4-11	3-7	2-5	1-2
Very poor	6 or fewer	4 or fewer	3 or fewer	2 or fewer	or fewer

B. The Sit-Up Test

The bent-knee sit-up test is probably the best field test available to evaluate abdominal muscle endurance.

- 🕮 Begin by lying on your back with your arms crossed on your chest. Your knees should be bent at approximately 90-degree angles, with your feet flat on the floor. Bringing your chest up to touch your knees and returning to the original lying position perform the complete sit-up.
- 🕮 Note that although the abdominal muscles are very active during the performance of a bent-leg sit-up, leg muscles such as hip flexors also play a role. Therefore, this test evaluates not only abdominal muscle endurance but hip muscle endurance as well.
- 🕮 Sit-up tests are generally considered to be relatively safe fitness tests, but two precautions should be mentioned. First, avoid undue stress on your neck during the "up" phase of the exercise. That is, let your abdominal muscles do the work; do not whip your neck during the sit-up movement. Second, avoid hitting the back of your head on the floor during the "down" phase of the sit-up. Performance of the test on a padded mat is helpful.

The protocol for the sit-up test is as follows:

- ✓ Select a partner to count your sit-ups, to hold your feet on the floor by grasping your ankles, and to assist in the timing of the test.

- ✓ Warm up with a few sit-ups. Give yourself a 2- to 3-minute recovery period after the warm-up and prepare to start the test.
- ✓ On the command "go," start performing sit-ups and continue for 60 seconds. Your partner should count your sit-ups aloud and inform you of the time remaining in the test period (perhaps by called-out 15-second intervals). Remember that only sits-ups performed correctly will be counted toward your total.
- ✓ After completing the sit-up test, use table 5.6 to determine your fitness classification.

Table 5.6 Fitness category based on sit-ups (1 min)

Age group (years)	Fitness category					
	V. poor	**Poor**	**Average**	**Good**	**Excellent**	**Superior**
			Men			
17-29	<17	17-35	36-41	42-47	48-50	>50
30-39	<13	13-26	27-32	33-38	39-48	>48
40-49	<12	12-22	23-27	28-33	34-43	>43
50-59	<8	8-16	17-21	22-28	29-38	>38
60+	<6	6-12	13-17	18-24	25-35	>35
			Women			
20-29	<14	14-18	29-32	33-35	36-47	>47
30-39	<11	11-22	23-28	29-34	35-45	>45
40-49	<9	9-18	19-23	24-30	31-40	>40
50-59	<6	6-12	13-17	18-24	25-35	>35
60+	<5	5-10	11-14	15-20	21-30	>30

5.4 Assessment of Flexibility

Flexibility is the ability to move joints freely through their full range of motion. Flexibility can decrease over time due to tightening of muscles and/or tendons. The key to maintaining flexibility is a program of regular stretching exercises. Individual needs for flexibility are variable. Some athletes, such as gymnasts, require great flexibility in order to perform complex movements in competition. In general, the non-athlete requires less flexibility than the athlete. Some flexibility, however, is required for everyone in order to perform common activities of

daily living or recreational pursuits. In some families the trait for loose joints is passed from generation to generation. This hyper mobility is sometimes referred to as joint looseness. Studies show that people with this trait may be more prone to dislocate patella. There is not much research evidence but some experts believe that those with hyper mobility or laxity may also be more susceptible to athletic or dance injuries. Especially to the knee and ankle and may be more apt to develop premature osteoarthritis.

5.4.1 Trunk Flexibility

The sit and reach test measures the ability to flex the trunk, which means stretching the lower back muscles and the muscles in the back of the thigh (hamstrings). The test is performed in the following manner.

- ✓ Start by removing your shoes and sitting upright with your feet flat against the box.
- ✓ Keeping your feet flat on the box and your legs straight, extend your hands as far forward as possible and hold this position for 3 seconds.
- ✓ Repeat this procedure three times. Your score on the sit and reach test is the distance, measured in inches, between the sit and reach box and the tips of your fingers during the best of your three stretching efforts.
- ✓ Note that a brief warm-up period consisting of a few minutes of stretching is recommended prior to performance of the test.
- ✓ To reduce the possibility of injury, participants should avoid rapid or jerky movements during the test. It is often useful to have partner help by holding your legs straight during the test and to assist in the recording of your score. After completing the test, consult table 5.7 to locate your flexibility fitness category.

Table 5.7 Physical fitness norms for trunk flexion using the sit and reach test.

Sit and reach score	Fitness classification
-6 to -15	**Very poor**
-1 to -5	**Poor**
0 to +1	**Average**
+2 to +3	**Good**

+3 to +5	**Excellent**
+6 or above	**Superior**

5.4.2 Shoulder Flexibility

As the name implies, the shoulder flexibility test evaluates shoulder range of motion (flexibility). The test is performed in the following manner.

- ✓ While standing, raise your right arm and reach down your back as far as possible. At the same time, extend your left arm behind your back and reach upward toward your right hand. The objective is to try to overlap your fingers as much as possible. Your score on the shoulder flexibility test is the distance, measured in inches, of finger overlap.
- ✓ Measure the distance of finger overlap to the nearest inch. For example, if your fingers overlap, score as a plus. If your fingers fail to overlap, record this score as minus. Finally, if your fingertips barely touch, record this score as zero (0).
- ✓ After completing the test with the right hand up, repeat the test in the opposite direction (left arm up). Note that it is common to be more flexible on one side than on the other.
- ✓ A brief warm-up period consisting of a few minutes of stretching is recommended prior to Performance of the shoulder flexibility test. Again, to prevent injury, avoid rapid or jerky movements during the test. After completion of the test, consult table 5.8 to locate your shoulder flexibility category.

Activity 5.3

Being in group just select at least one fitness evaluation method for each of the fitness components discussed above and try to assess where your fitness status will be.

Table 5.8 Physical Fitness Norms for Shoulder Flexibility:

Right Hand Up Score	Left Hand Up Score	Fitness Classification
<0	<0	Very poor
0	0	Poor
1	+1	Average
+2	+2	Good

+3	+3	Excellent
+4	+4	Superior

5.5 Assessment of Body Composition

Every person should possess at least a minimal amount of fat (percent body fat) for a good health. This fat is called essential fat and is necessary for temperature regulation, shock absorption and regulation of essential body nutrients, including vitamins A, D, E and K.

The exact amount of body fat considered essential to normal body functioning has been debated. But most experts agree that males should possess no less than 5% and females no less than 10%. Recall that a high percentage of body fat is associated with an increased risk of heart disease and other diseases. It is therefore not surprising that several methods of assessing body composition have been developed. A technique considered being the gold standard for laboratory assessment of body fat in humans is hydrostatic weighing and involves weighing the individual both on land and in a tank of water. The two body weights are then entered into a simple formula to calculate the percent of body fat. Unfortunately, underwater weighing is very time consuming and requires expensive equipment. Thus, this procedure is rarely employed to assess body composition in collegiate physical fitness courses. A rapid and inexpensive method to assess body composition is measurement of subcutaneous fat or fat beneath the skin (called the skin fold test).

5.5.1. The Skin Fold Test

Subcutaneous fat is measured using an instrument called a skin fold caliper. The skin fold test relies on the fact that over 50% of body fat lies just beneath the skin. Therefore, measurement of representative samples of subcutaneous fat provides a means of estimating overall body fatness. Skin fold measurement to determine body fat is reliable but generally has a ±3% to 4% margin of error.

One of the most accurate skin fold tests to estimate body fatness requires three skin fold measurements for both men and women. The anatomical sites to be measured in men (chest, triceps, and sub scapular skin folds) and the measurement sites for women (triceps, suprailium, and abdominal skin folds). Note that for standardization, all measurements should be made on the

right side of the body.

1. To make each measurement, hold the skin-fold between the thumb and index finger and slowly release the tension on the skin fold calipers so as to pinch the skin fold within 1/2 inch of your fingers. Continue to hold the skin fold with your fingers and fully release the tension on the calipers; then, simply read the number (the skin fold thickness in millimeters) from the gauge. Release the skin fold and allow the tissue to relax. Repeat this procedure three times and average the sum of the three measurements.
2. After completing the three skin fold measurements, total the measurements and use Tables 5.9 and 5.10 to determine the percent body fat for women and men, respectively. After obtaining your percent body fat, refer to table 5.11 to determine the body composition fitness category, and record your score.

Table 5.9 Percent fat estimate for women sum of triceps, abdomen, and suprailium skin folds

SSF	Age (years)								
	18-22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	>57
8-12	8.8	9.0	9.2	9.4	9.5	9.7	9.9	10.1	10.3
13-17	10.8	10.9	11.1	11.3	11.5	11.7	11.8	12.0	12.2
18-22	12.6	12.18	13.0	13.2	13.4	13.5	13.7	13.9	14.1
23-27	14.5	14.6	14.8	15.0	15.2	15.4	15,6	15.7	15.9
28-32	16.2	16.4	16.6	16.8	17.0	17.1	17.3	17.5	17.7
33-37	17.9	18.1	18.3	18.5	18.7	18.9	19.0	19.2	18.4
38-42	19.6	19.8	20.0	20.2	20.3	20.5	20.7	20.9	21.1
43-47	21.2	21.4	21.6	21.8	21.9	22.1	22.3	22.5	22.7
48-52	22.8	22.9	23.1	23.3	23.5	23.7	23.8	24.0	24.2
53-57	24.2	24.4	24.6	24.8	25.0	25.2	25.3	25.5	25.7
58-62	25.7	25.9	26.0	26.2	26.4	26.6	26.8	27.0	27.1
63-67	27.1	27.2	27.4	27.6	27.8	28.0	28.2	28.3	28.5
68-72	28.4	28.6	28.7	28.9	29.1	29.3	29.5	29.7	29.8
73-77	29.6	29.8	30.0	30.2	30.4	30.6	30.7	30.9	31.1
78-82	30.9	31.0	31.2	31.4	31.6	31.8	31.9	32.1	32.3
83-87	.32.0	32.2	32.4	32.6	32.7	32.9	33.1	33.3	33.5
88-92	33.1	33.3	33.5	33.7	33.8	34.0	34.2	34.4	34.8
93-97	34.1	34.3	34.5	34.7	34.9	35.1	35.2	35.4	35.6

98-102	35.1	35.3	35.5	35.7	35.9	36.0	36.2	36.4	36.6
103-107	36.1	36.2	36.4	36.6	36.8	37.0	37.2	37.3	37.5
108-112	36.9	37.1	37.3	37.5	37.7	37.9	38.0	38.2	38.4
113-117	37.8	37.9	38.1	38.3	39.2	39.4	39.6	39.8	39.2
118-122	38.5	38.7	38.9	39.1	39.4	39.6	39.8	40.0	40.0
123-127	39.2	39.4	39.6	39.8	40.0	40.1	40.3	40.5	40.7
128-132	39.9	40.1	40.2	40.4	40.6	40.8	41.0	41.2	41.3
133-137	40.5	40.7	40.8	41.0	41.2	41.4	41.6	41.7	41.9
138-142	41.0	41.2	41.4	41.6	41.7	41.9	42.1	42.3	42.5
143-147	41.5	41.7	41.9	42.0	42.2	42.4	42.6	42.8	43.0
148-152	41.9	42.1	42.3	42.4	42.6	42.8	43.0.	43.2	43.4
153-157	42.3	42.5	42.6	42.8	43.0	43.2	43.4	43.6	43.7
158-162	42.6	42.8	43.0	43.1	43.3	43.5	43.7	43.9	44.1
163-167	42.9	43.0	43.2	43.4	43.6	43.8	44.0	44.1	44.3
168-172	43.1	43.2	43.4	43.6	43.8	44.0	44.2	44.3	44.5
173-177	43.2	43.4	43.6	43.8	43.9	44.1	44.3	44.5	44.7
178-182	43.3	43.5	43.7	43.8	44.0	44.2	44.2	44.6	44.8

Key: SSK = Sum of skin folds

Table 5.10 Percent fat estimate for men sum of triceps, and sub scapula skin folds

SSF	**Age (years)**								
	<22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	>57
8-10	1.5	2.0	2.5	3.1	3.6	4.1	4.6	5.1	5.6
11-13	3.0	3.5	4.0	4.5	5.1	5.6	6.1	6.6	7.1
14-16	4.5	5.0	5.5	6.0	6.5	7.0	7.6	8.1	8.6
17-19	5.9	6.4	6.9	7.4	8.0	8.5	9.0	9.5	10.0
20-22	7.3	7.8	8.3	8.8	9.4	9.9	10.4	10.9	11.4
23-25	8.6	9.2	9.7	10.2	10.7	11.2	11.8	12.3	12.8
26-28	10.0	10.5	11.0	11.5	12.1	12.6	13.1	13.6	14.2
29-31	11.2	11.8	12.3	12.8	13.4	13.9	14.4	14.9	18.5
32-34	12.5	13.0	13.5	14.1	14.6	15.1	15.7	16.2	16.7
41-43	16.0	16.6	17.1	17.6	18.2	18.7	19.3	19.8	20.3
44-46	17.1	17.7	18.2	18.7	19.3	19.8	20.4	20.9	21.5
47-49	18.2	18.7	19.3	19.8	20.4	20.9	21.4	22.0	22.5
50-52	19.2	19.7	20.3	20.8	21,4	21.9	22.5	23.0	23.6
53-55	20.2	20.7	21.3	21.8	22.4	22.9	23.5	24.0	24.6

56-58	21.1	21.7	22.2	22.8	23.3	23.9	24.4	25.6	25.5
59-61	22.0	22.6	23.1	23.7	24.2	24.8	25.3	25.9	26.5
62-64	22.9	23.4	24.0	24.5	25.1	25.7	26.2	26.8	27.3
65-67	23.7	24.3	24.8	25.4	25:9	26.5	27.1	27.6	28.2
68-70	24.5	25.0	25.6	26.2	26.7	27.3	27.8	28.4	29.0
71-73	25.2	25.8	26.3	26.9	27.5	28.0	28.6	29.1	29.7
74-76	25.9	26.5	27.0	27.6	28.2	28.7	29.3	29.9	30.4
77-79	26.6	27.1	27.7	28.2	28.8	29.4	29.9	36.5	31.1
80-82	27.2	27.7	28.3	28.9	29.4	30.0	30.6	31.1	31.7
83-85	27.7	28.3	28.8	29.4	30.0	30.5	31.1	31.7	32.3
86-88	28.2	28.8	29.4	29.9	30.5	31.1	31.6	32.2	32.8
89-91	28.7	29.3	29.8	30.4	31.0	31.5	32.1	32.7	33.3
92-94	29.1	29.7	30.3	30.8	31.4	32.0	32.6	33.1	33.4
95-97	29.5	30.1	30.6	31.2	31.8	32.4	32.9	33.5	34.1
98-100	29.8	30.4	31.6	31.6	32.1	32.7	33.3	33.9	34.4
101-103	30.1	30.7	31.3	31.8	32.4	33.0	33.6	34.1	34.7
104-106	30.4	30.9	31.5	32.1	32.7	33.2	33.8	34.4	35.0
107-109	30.6	31.1	31.7	32.3	32.9	33.4	34.0	34.6	35.2
110-112	30.7	31.3	31.9	32.4	33.0	33.6	34.2	34.7	35.3
113-115	30.8	31.4	32.0	32.5	33.1	33.7	34.3	34.9	35.4
116-118	30.9	31.5	32.0	32.6	33.2	33.8	34.3	34.9	35.5

Key: SSK = Sum of skin folds

Table 5.11 Body Composition fitness categories for men and women

Percent Body Fat	Body Composition Fitness Category
	Men
<10%	Low body fat
10-20%	Optimal range of body fat
21-25%	Moderately high body fat
26-31%	High body fat
>3l%	Very high body fat
	WOMEN
<15%	Low body fat
15-25%	Optimal range of body fat
26-30%	Moderately high body Fat
31-35%	High body fat

>35%'	Very high body fat

5.5.2. Estimation of Body Composition: Field Techniques

Several quick and inexpensive field techniques exist to evaluate body composition and the risk of heart disease associated with over-fatness. Here we describe some of the more popular procedures currently in use.

A. Waist-to-Hip Circumference Ratio: recent evidence suggests that, the waist-to-hip circumference ratio is an excellent index for determining the risk of disease associated with high body fat. The rationale for this technique is that, a high percentage of fat in the abdominal region is associated with an increased risk of disease (such as heart disease or hypertension). Therefore, an individual with a large fat deposit in the abdominal region would have a high waist-to-hip ratio and would have a higher risk of disease than someone with a lower waist-to-hip ratio. The procedure for assessment of waist-to-hip circumference ratio is as follows:

1. Both waist and hip circumference measurements should be made while standing, using a non-elastic tape. It is important that bulky clothing not be worn during the measurement, because it could bias the circumference measurement. During measurement, the tape should be placed tightly around the body but should not press into the skin. Record your measurements to the nearest millimeter or sixteenth of an inch.
2. Perform the waist measurement first. Begin by placing the tape at the level of the umbilicus. Make your measurement at the end of a normal expiration.
3. To make the hip measurement, place the tape around the maximum circumference of the buttocks.

After completing the measurements, divide the waist circumference by the hip circumference to determine the waist-to-hip ratio. Use Table 5.12 to determine the hip-to-waist ratio rating.

Table 5.12 Waist –to –hip circumference ratio rating scale Classification

Risk of disease	Men	Women
High risk	>1.0	>0.85
Moderately high risk	0.90-1.0	0.80-0.85

Optimal low risk of disease	<0.90	<0.80

B. Body Mass Index: Although many limitations exist, research has shown that the body mass index (BMI) is a useful technique for placing people into categories of normal or too much body fat. The BMI is simply the ratio of the body weight (kilograms; kg) divided by the height (in meters) squared (m2): BMI = weight (kg)/height (m2)

(Note: 1 kg = 2.2 pounds and 1 m = 39.25 inches.) For example, if an individual weighs 64.5 kg and is 1.72 m tall, the BMI would be computed as follows: 64.5 kg/(1.72 m)2 = 64.5/2.96 = 21.8

Table 5.13 Body Mass Index Classification of the Degree of Body Fatness

Degree of obesity	**BMI**	
	Men	**Women**
Optimal body fat	<25	<27
Moderately high body fat	25 – 30	27 – 30
High body fat	31 – 40	31 – 40
Very high body fat	>40	>40

After calculation of your BMI, use Table 2.16 to determine your degree of body fatness. The concept behind the BMI is that individuals with low percent body fat will have a low BMI. For example, men and women with a BMI of less than 25 and 27, respectively, are classified as being non-obese. In contrast, men and women with a BMI of greater than 40 are considered to be extremely obese.

Activity 5.4

Based on the above techniques of BMI, just calculate your own BMI and find where you will be in the BMI classification of the degree of body fatness.

UNIT SUMMARY

Prior to beginning an exercise training program, to have an objective fitness and health status evaluation is important. Particularly, if the individuals are over 30 years old, obese and sedentary must have a medical exam at the beginning of an exercise training program.

Even though, laboratory tests are very expensive and an affordable for most individuals, scholars

has provided us with numerous field methods by which we could use to measure our fitness status. For example, cardiorespiratory fitness could be measured with the following simple field test. Such as 1.5 mile run test, 1 mile walk test and step test.

SELF-TEST EXERCISE

What is the importance of having a medical exam and fitness assessment prior to an exercise training program?

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